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CRITICAL REMARKS ON THE THEORIES OF FUNDAMENTAL COLOUR SENSATIONS.

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IT must be admitted, I think, that the idea of fundamental colours has rather impeded than advanced our knowledge of the phenomena and nature of colour blindness. The numerous and laborious examinations that have been made with the object of detecting and classifying cases of colour blindness have been conducted mainly by those who have tried to reconcile the results obtained with one or other of the current hypotheses (Young's, as modified by Helmholtz, or Hering's). The support which Young's hypothesis has received from such weighty authorities as Maxwell, Helmholtz, and Donders, &c., has necessarily given it a very firm hold of the minds of physicists and physiologists. Indeed the existence of the three different end-organs or conducting fibres which are supposed to respond in different ways to different stimuli is often referred to as little short of a certainty. Now, however satisfactory such a hypothesis may be as an explanation for colour vision in the normal state, the altered nature of the function of one or all of the end-organs, which it becomes necessary to assume in the case of colour blindness, does not adequately

account for the particular conditions of colour perception which characterise that state. This at least is the case with reference to the colour blindness existing for the peripheral parts of the retina in everyone who has otherwise normal colour perception. This kind of colour blindness is easily studied, and the facts in connection with it, which it is of importance to consider, are as follows:—For the outermost portions of the retina there is total colour blindness. For a less peripheral zone the defect is only partial (red-green blindness). In neither case does the colour blindness appear to be complete, as it has been found that the boundaries of the area of correct colour appreciation are wider for very bright colours. In the partially colour blind area only two complementary hues—a particular yellow and a particular blue—are seen in the same manner as they are seen at the centre; all others appear yellowish (brownish), or bluish, and at the same time fainter or dirtier in colour, according to the hue and shade examined in this way. Two other hues may be found with some trouble which, within the same partially colour blind area appear uncoloured (neutral grey), viz., a particular green, or bluish-green, and its complement, a particular rose-red or red. Those four hues might in a certain sense—inasmuch, namely, as they always give rise to the same impression as soon as they become visible as coloured at all—be called fundamental colours, and they correspond to those which, according to Hering's hypothesis, are the fundamental ones. Again, it is possible to find a great number of different pairs of hues which, although giving rise to altogether different colour impressions when viewed directly by the normal eye, appear similar when seen with the peripheral portions of the retina, as they both give an impression corresponding to some tint or shade of one of the only two hues which are there seen correctly.

Another important fact in connection with the physiology of vision in the normal eye is that a white object

when carried from the periphery to the centre, or *vice versa*, does not become coloured, but remains white. This is the natural result of the peripheral colour defect being always equal for hues which are complementary, and of the remaining dichromatic vision being one in which two complementary colours are equally visible.

Whilst, however, it is possible to compare the appearances which different hues present, when seen by the colour blind portion of the retina, with that which they present on direct fixation, it is not possible for the normal eye to appreciate with certainty the impressions to which different hues give rise in colour blind individuals. Colour blindness, as it occurs congenitally, is not exactly similar to the normal colour blindness of the peripheral portions of the retina. It is certainly, however, a very analogous condition, the differences being probably mainly, if not entirely, such as result from its greater completeness and the greater differences in the complementary hues which in each particular case appear devoid of any colour—*i.e.*, neutral or grey. But it is not necessary that we should know exactly how the colour blind see colours to test the validity of the Young-Helmholtz theory; we need only demand that it should afford a satisfactory explanation of the facts of normal colour blindness enumerated above. This, I venture to say, it cannot do. At all events, neither the complete loss of functional activity in one of the three fundamental end-organs or conducting fibres, nor the supposed abnormal diminution in the extent to which all respond to definite physical stimuli, can explain both the dichromatic spectrum and the unaltered impression produced by a white object.

The same objection cannot be raised against Hering's hypothesis. On the assumptions made by Hering an apparently satisfactory explanation of normal peripheral colour blindness can be given, and, therefore, presumably also of congenital colour blindness. The question rather which suggests itself is, "Is there any good reason for

assuming that there are any fundamental colour sensations at all?" So far as I am aware, the first to seriously question the existence of primary or fundamental colour sensations was Krenchel. He pointed out that it is strange that, if there were such, we should be so absolutely unconscious of them. Who, for instance, taking the red of the spectrum, can say of any particular part of it, although the impression to which it gives rise is easily recognised from those produced by the hues on either side of it, that it is a pure red, a purer red than anything else, a primary, or a fundamental impression? What every one with normal colour vision can do, and what is therefore a test of normal colour vision, is to recognise a definite series in the hues of the spectrum which are sufficiently distinct to be recognised as different. Every one can place in a definite order a very large number of different hues, beginning with red, and passing through orange-red, reddish-orange, orange, yellow, &c., to violet. This is completely unintelligible to the colour blind, but is readily apparent to every one possessed of normal colour vision, and yet no one can say that to every one with normal colour vision the same hues give rise to identically the same impressions. The test for normal colour vision is simply that this unbroken series of impressions is recognised. This is all we know of the physical transformation or elaboration of the physical conditions which form the basis of colour. As to the physical conditions, much is of course known, and in this connection it may be worth while noting the following points:—In the first place, there is an unbroken series of ether vibrations of different velocity, which are capable of being appreciated as colours. The series, though continuous, does not embrace vibrations which have ever so great a ratio as 2 : 1. That is to say, there is nothing similar to the octave in sound vibrations.

[The series of sensations, too, corresponding to the vibrations of different velocity, is one in which a similar colour impression does not occur twice, but in which,

nevertheless, we are conscious of an approximation at either end. The interval left can indeed be filled up by colours of which we may become conscious in other ways than by the action of homogeneous light on the retina. Why it should be that the number of possible different colour impressions should be greater for some parts of the spectrum than for others, and that impressions which we are capable of receiving in other ways should not be elicited by simple vibrations, is not clear.]

Again, the same colour sensation—as far at least as hue is concerned—is got not only from the effect of vibrations of one velocity alone (homogeneous light) on the percipient elements of the retina, but also from the simultaneous action of vibrations which, acting alone, would give rise to impressions of colour occupying positions on either side of it in the series of possible colour sensations. This fact, taken along with the incompleteness of the octave of colour-eliciting vibrations, and the great difference in the nature of the vibrations themselves, is, as it appears to me, sufficient to exclude all analogy between the sensations of sound and colour, which is, nevertheless, often assumed to exist. The simultaneous action, then, of any two homogeneous light vibrations gives rise to an intermediary colour impression. It is, consequently, possible to select any number greater than two (therefore three at least) which, by suitable combinations, will give rise to all possible colours. [This fact has no doubt contributed greatly to the notion of the existence of a few fundamental colours.] The further the component vibrations are separated from each other in the spectrum, the less saturated is the resulting colour impression until it becomes altogether neutral, and the component vibrations are such as give rise to complementary colours. If then, we assume, as Hering does, that there are only four fundamental colour sensations, and that all others are simply combinations of two of these, it seems not only strange that we should not be conscious of a particular purity in these fundamental colours, but

that there should be such an equal sensation of saturation about all the spectral colours.

We know, then, the primary cause of colour sensations, and the final result. Of the intermediary stages in the process—viz., the manner in which the definite physical conditions become changed into definite physical impressions, little is known. It is known, of course, that the first transformation takes place in the retina, and that the brain receives the retinal impressions, which are conveyed to it along the optic nerves. But we do not know what is the nature of the transformation that takes place in the retina, or of the resulting primary excitation in the brain which awakens the consciousness of colour. It is natural that there should be speculation as to the manner in which the intermediary process is accomplished. One can readily understand, too, that the fact that it is possible to obtain all colours from three or more colours variously combined, taken along with the doctrine of specific nerve energies of Johannes Müller, should create a strong leaning towards the fundamental colour hypotheses. Apart, however, from this, there does not appear to be any reason for making such an assumption; there is, in fact, no evidence of the existence of primary colours, either in the physical basis or final consciousness of colours; in other words, in all we know anything about.

A question which naturally suggests itself is, where is the defect in colour blindness? Is it in the retina, in the optic nerve, or in the brain? So far as pathological conditions go, there is never any great disproportion met with between the colour and form sense defects in any case of purely retinal disease—that is to say, disease involving only the percipient layers of the retina; the changes in colour vision to which such alterations give rise are similar to what is caused by diminished illumination; colours are seen much as they are in semi-darkness. On the other hand, colour vision appears to be disproportionately reduced, as compared with vision for form in all cases where

the conducting mechanism is implicated. This is most marked where it may be assumed that there is a general lowering of the conductibility of contiguous groups of optic nerve-fibres, as in the various forms of amblyopia affecting the centres of the retina (toxic amblyopia, retro-bulbar neuritis). It is in cerebral changes, however, that the greatest proportionate defects in colour vision are found—alterations in the retinal elements and optic nerves produce a lowering of colour perception, not merely red-green blindness, though this, especially in the latter cases, is often most marked, corresponding to the less perfect development of red-green vision at some parts of the normal retina. In the case of changes localised in the brain this tolerably equal distribution, or impaired vision for all colours, is also what is most frequently met with (in hemiachromatopsia, for instance); but cases have been recorded in which a purely red-green blindness has been acquired. The experience of pathology would render it probable, then, that the abnormality in colour-blindness is a central cerebral one, and not retinal, *i.e.*, that the retina of the colour blind responds in the same manner to the ordinary physical stimuli, but that, for some reason or other, the psychical result is an abnormal one. This appears to me, too, to be all the more probable from the fact that, under altogether normal conditions of colour vision, the same physical stimulus does not necessarily give rise to the same colour impression. This is seen in the well-known phenomenon of simultaneous contrast.

So far as the primary transformation of light waves goes, it is certainly not necessary to assume the existence of unknown elements in the retina in order to imagine a manner in which it may respond differently to qualitatively different stimuli. It has long been known that alterations in the pigment of the hexagonal cells of the retina are associated with defects in the light sense, and recent experiments by Engelmann, Van Genderen Stort, and others, have shown that changes actually take place

in the disposition of the pigment in these cells by the action of light. The retinal pigment must, therefore, be looked upon as in some sense an end-organ. It is at least not impossible, then, that a different proportionate stimulation may be produced in the cones and pigment for each appreciable difference in wave-length or combination of homogeneous stimuli.* What would seem more likely, however, inasmuch as the colours resulting from homogeneous light are always more saturated than the similar ones otherwise produced, is that the stimulation of the pigment in each case merely gives rise to the sensation of light, while the different action of different wave-lengths and the equivalent more complicated stimuli on the cones in some manner elicits the qualitative differences in the impressions produced. That there is some intimate connection between the stimulations of those two end-organs in their relation to colour perception is apparent, too, from the fact that colour impressions are different according to the degree of illumination if below or beyond a certain intensity. The shortening of the spectrum, too, met with in some colour blind people, and the incompleteness of the octave of colour impressions from homogeneous light may have something to do with this. The shortened spectrum has, so far as I know, not been shown to be a peculiarity of the colour blind state. The greatest stumbling block, however, is presented by the physiological notion of specific nerve energies. According to this doctrine it would appear unlikely that such a multitude of different impressions could be conveyed to the brain, as must necessarily be the case if there were there a direct consciousness of the differences in the manner in which the transformation of energy took place in the retina for each and every different colour which it is possible to distinguish. But we cannot say that such is not the case. Some have imagined a transmission by periodic variations

* See Gunn, "On the Nature of Light-Percipient Organs and of Light- and Colour- Perception," Ophth. Hosp. Reports, vol. xii, pp. 131, 132.

in the nerve currents (which, of course, is the only energy transmitted along the nerve), leading to a reproduction of the same physical state in the cerebral cells at the visual centres, analogous to the manner in which sound vibrations are reproduced in the telephone. In the telephone the velocity of the current which transmits and reproduces the periodic vibrations is enormously rapid as compared with the vibrations. Light vibrations have, on the contrary, such a much greater velocity than the nerve current, that it is almost inconceivable that there could be a similar transmission—that is to say, if we imagine an altogether analogous and, so to speak, direct transmission. It is not inconceivable, however, that the transformation of energy which takes place in the retina may be of such a nature as to render its reproduction (that is to say, the reproduction of the same molecular state in the brain) quite compatible with the slower transmission of energy along the optic nerve. At all events, it is impossible to say that this is not, or cannot, be the case.

If we imagine, then, that the different way in which the different physical causes produce stimulation of the end-organs, each give rise to correspondingly different states in the molecular activity of the cerebral cells, then we might suppose further, that when colour vision is normal the molecules may be put into their particular state of activity equally well by all the different physical stimuli capable of giving rise to different colour impressions. In the colour blind, on the other hand, we might suppose that only one particular state (or rather two connected in some intimate manner) can be set up by all these same physical causes of stimulation. The resulting impressions in the case of the colour blind would, therefore, only correspond to the normal when they were such as would in the normal brain give rise to the same impression by calling forth the same molecular state.

In my paper of 1879* I referred to the manner in

* Edinburgh Medical Journal.

which Krenchel illustrated this or an essentially similar idea. I have since been in the habit of adopting the following illustration, and I use it, of course, merely as an illustration, not as an attempt to explain what actually takes place. I use it, too, in preference to Krenchel's, only because I think it meets better the kind of complete independence that there seems to be in some particulars between light alone and colour. The illustration is to be found in the property that certain bodies have of polarising light. While light vibrations in all directions will pass through many transparent media, only those in one direction will pass without interruption through the polarising crystal; vibrations in planes at right angles to that particular direction are altogether excluded, and the proportion of energy transmitted as light is greater the more nearly the direction of vibrations coincides with that in which they pass without interruption, and less the more nearly it coincides with that at right angles to this. Now let us represent by way of illustration as a condition similar to that of polarised light the state of the brain cells in colour blindness. Let us say that whereas where normal colour vision exists molecular movements or changes take place in all directions, in colour blindness movements or changes, in one direction only, result in response to all stimuli, and that that one direction represents the two complementary hues which are properly seen.

It is evident that there must either be different molecular states set up in the visual brain cells which awaken the consciousness of different colours, or a power of analysing the different intensities of impressions in a few cells which respond always in the same manner, though with varying intensity, to the different physical stimuli, and of thus elaborating the numerous different colour sensations. The latter is what must be assumed if fundamental colours are supposed to have any existence. Now, inasmuch as both physiological experiment and

pathology (*e.g.*, symmetrical scotomata from brain lesions in the two eyes) point to there being a very close arrangement in the brain of the centres for corresponding points of the two retinæ, it would be natural to suppose that, were the consciousness of colour aroused by the elaboration in a still higher centre of the relative stimulation of different fundamental colour brain-elements, different colours affecting simultaneously corresponding points should be blended into the proper intermediate colour-impression. But this is not the case. The fact is, as it seems to me, one argument against Hering's hypothesis. Other objections which may be advanced are (2) that it is by no means always the same hues which to the colour blind are altogether colourless; (3) that there is no consciousness of fundamental colours; and, lastly, that the assumption is unnecessary, because, although it may offer an explanation for the principal phenomena of colour blindness, that condition may be explained by making assumptions which, in the present state of our knowledge, are quite as legitimate.

So much for theory—practically I believe the ordinary test for colour blindness, which consists in causing the individual to match colours, is completely satisfactory for the detection of that condition. The classification, too, into red-green blindness or blue-yellow blindness, is a sufficiently good practical classification. A more scientific classification, or one less open to objection from a scientific point of view, would be got from the determination in each case of the neutral hue or hues in the spectrum, or the neutral hues as tested with Maxwell's disc.

NOTES ON GLIOMA RETINÆ, WITH A REPORT OF 60 CASES.

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The enquiry, the results of which are embodied in this report, was undertaken chiefly for the purpose of ascertaining, whenever possible, the after-history of cases of glioma of the retina. In this we have been only partially successful, the migratory habits of that class from which the majority of hospital patients are derived, leading to the frequent failure of any attempt to trace the patients or their relatives, for more than a few months after they left the hospital.

We append a tabular statement of the cases. Of the total number (60 patients, 66 eyes), 55 were cases in the Hospital during the years 1871 to 1890. For notes of four of the other five cases we are indebted to Messrs. Marcus Gunn, Stanford Morton, and Jessop (London), and Mr. J. Elliott Square (Plymouth). The remaining case was under the care of one of the writers.

Several of the earlier cases have been already reported by Nettleship and Brailey in the Ophthalmic Hospital Reports; we have included them in our list because in some instances the further history of the patient has been obtained, and because they add to the statistical value of our paper.

Reference to the tables will show the points upon which we have endeavoured to gain information, but many of the cases are necessarily incomplete. The following summary of remarks upon the cases may prove of some interest. We have carefully searched the literature

of the subject in reference to several questions of importance, and the information thus obtained is embodied in our remarks, and the results compared with our own. We may here state that we have made every effort to exclude cases in which there appeared to be reasonable doubt that the diagnosis of glioma was correct; such were cases in which no microscopic examination of the growth had been recorded, or in which the reports were too scanty to be reliable.

Sex.—Of the 60 cases, 30 were males, 27 females, and in 3 the sex was not given. These figures show a slight preponderance of males. In previously published tables the numbers were: Hirschberg, 77 cases, 37 males, 24 females, 16 undetermined; Vetsch, 22 cases, equally divided between the sexes; Lukowicz, 27 cases, 11 males, 15 females, 1 undetermined; Knapp, 7 cases, 6 males, 1 female. Adding these figures, we get, of 193 cases, 95 males, 78 females, and 20 undetermined.

Eye affected.—Of our 60 cases, the growth occurred simultaneously, or with short interval, in both eyes in 12 (Nos. 6, 9, 10, 19, 21, 26, 34, 35, 36, 46, 55, 60); in 4 others (Nos. 8, 17, 20, 51) there is decided probability that the disease attacked both eyes; and in one (No. 58) the affection of the second eye may have been glioma. Of those in which the disease was unilateral, the right eye was affected in 16 cases, the left in 27 cases, and in one it was not stated. Of 60 of Hirschberg's cases, in 14 both eyes were affected; in 25 the right, and in 21 the left, eye was the seat of the new growth.

Vetsch records 22 cases, in one of which the disease was bilateral; in 11 the right eye and in 10 the left eye was affected.

Age of Patients.—There is generally considerable difficulty in obtaining an accurate statement from the parents, as to the date at which attention was directed to the child's eye. The figures which are given in the tables can only be taken as approximately correct. Classifying

our cases roughly, we obtain the following results: the disease was first noticed by the parents:—

Within three months of birth, in 9 cases; of these it was noticed "at birth" in 5 cases, during the first five weeks of life in 2 cases.
Between 3 and 6 months, 4 cases.
„ 6 „ 12 „ 9 „
During 2nd year, 13 cases.
„ 3rd „ 7 „
„ 4th „ 3 „
„ 5th „ 4 „
„ 6th „ 4 „
„ 7th „ 1 „
Age uncertain 6 „

From these figures it appears that the growth begins, or more correctly becomes evident, with greatest frequency during the first two years of life. There is no doubt that glioma of the retina is, in some cases, present at birth.

Hirschberg out of 77 cases gives 6 as congenital.

Vetsch out of 22 cases gives 3 as congenital.

In our oldest case, disease was first noticed during the 7th year. Hirschberg reports 4 cases at an older age, viz., 1 at 9 years, 2 at 10 years, and 1 at 11 years.

Vetsch gives 1 at 8 years; Lukowicz gives 1 at 9 years of age.

Recoveries.—We have considered as permanent recoveries only those cases in which we have obtained reliable information that the patient was alive and well, and that no recurrence of the disease had occurred, *three years* after the removal of the eye or eyes. Our reason for fixing three years as a limit is that one case has been recorded by Vetsch, in which three years after the removal of the eye a secondary growth occurred in the parotid gland, which was decided by microscopic examination to be gliomatous. We must add, however, that this is a unique case, and that the usual interval between the

operation upon the primary and the appearance of the secondary growth is much shorter. In our tables the longest period of quiescence was nine months (Case 8). In view of this single case, it seems that a patient cannot be pronounced safe under three years from the date of operation.

Of our 60 cases, we find 8 which, according to this test, may be regarded as permanent recoveries. They are as follows:—

Case	1,	19 years.
,,	16,	$11\frac{3}{4}$,,
,,	23,	$14\frac{1}{2}$,,
,,	29,	$5\frac{2}{3}$,,
,,	39,	$4\frac{1}{2}$,,
,,	43,	$3\frac{1}{2}$,,
,,	45,	$3\frac{1}{12}$,,
,,	46,	3 ,,

Case 1.—Reported in Ophth. Hosp. Reports, vol. ix, p. 46. We have recently examined this specimen, which is in the Hospital Museum, and are satisfied as to its nature. We have also seen the patient within the last six months.

Case 16.—Reported in Ophth. Hosp. Reports, vol. x, p. 251. We have examined the slides made at the time of excision, and have no doubt of the gliomatous character of the growth. The patient is known to be alive and well in New Zealand.

Case 23.—Reported in Ophth. Hosp. Reports, vol. viii, p. 545. Patient alive and well (in Rome) February, 1890.

Case 29 (not reported).—The slides made at the time of removal of the eye have been recently examined by us. There is no doubt the tumour is glioma. Patient seen in February, 1890, in good health. Other eye normal.

Case 39.—Slides re-examined and growth determined to be glioma. Child reported by parents alive and well.

Case 43.—Slides re-examined; certainly glioma. Child alive and well in July, 1890.

Case 45.—Slides made three years ago re-examined, and diagnosis confirmed. Child reported by father alive and well.

Case 46.—Slides re-examined. They show undoubted glioma. Child reported by father alive in November, 1890.

Of the remaining 52 cases, 6 are known to be still alive, but none of these having reached the three-year limit they are not included in the above list. One (No. 55) is a case of double excision, and, up to the present time, $2\frac{1}{6}$ years have elapsed since the removal of the second eye. The other 5 are cases in which the disease was uniocular; in No. 50, 1 year and 5 months have elapsed since the eye was excised; in No. 56, 1 year and 10 months; in No. 57, 2 years and 4 months; in No. 59, 9 months; in No. 60, 9 months (the fellow eye is, however, affected in this case).

In the literature of the subject we have found records of altogether 25 cases of permanent recoveries, using this term in the sense defined above. They are briefly as follows :—

Brudenell Carter. 1 case, 9 years.
Hirschberg. 1 case, $12\frac{1}{2}$ years.
„ 1 „ $3\frac{1}{2}$ „
Fouchard. 1 case, $16\frac{1}{2}$ years. There was no microscopic examination of the specimen.
Nellessen. 1 case, $4\frac{1}{4}$ years. In this case a recurrent growth in the orbit was removed, and the contents of the orbit cleared out. The patient was alive and well $4\frac{1}{4}$ years after the second operation.
Knapp. 1 case, 14 years.
„ 1 „ 6 „ after exenteration of orbit.
Landsberg. 1 case, 16 years.
„ 1 „ 3 „
Agnew. 1 case of double enucleation, 14 years.
Brière. 1 case, 4 years.
Lawson. 1 case, 8 years.
„ 1 „ 7 „
Vetsch. 1 case, 9 years.
„ 1 „ 7 „
Theobald. 1 case, $9\frac{1}{2}$ years. No microscopical examination.
Snell. 1 case, 12 years.*

* Reported in Brit. Med. Jour., 1884, ii, 1194. Mr. Snell has informed us that the patient is now (August, 1890) alive and well.

Noyes. 1 case, $14\frac{1}{2}$ years.
Macfarland. 1 case, 5 years.
Hodges. 1 case, 9 years.*
Lukowicz. 1 case, $12\frac{1}{3}$ years.
" 1 " $8\frac{2}{3}$ "
" 1 " $6\frac{2}{3}$ "
" 1 " $6\frac{1}{2}$ "
" 1 " $5\frac{1}{4}$ "

Agnew's case is especially noteworthy. It and our No. 46 are, so far as we know, the only cases hitherto recorded in which permanent cure has resulted after double enucleation for glioma; No. 55, in our tables, also a double case, is alive at this date, but the time which has elapsed since the operation upon the second eye is only $2\frac{1}{6}$ years.

The percentage of permanent recoveries in the cases published by different authors varies considerably: thus Vetsch records 2 out of 25; Lukowicz, 5 out of 27; we have 8 out of 60.

Duration of Life after Operation in Fatal Cases.

Twenty-eight of our 60 cases are known to have terminated fatally. Of these six (Nos. 6, 10, 21, 26, 34, 35) were cases in which both eyes were certainly affected, and in four of them (Nos. 6, 26, 34, 35) double enucleation was performed (not simultaneously). The longest duration of life after removal of the second eye was eight months (No. 35). In five others (Nos. 8, 17, 20, 51, 58) both eyes were blind, but there is some doubt as to the nature of the disease in the second eye (see tables).

In the cases in which one eye only was affected the longest duration of life after its removal was 14 months (No. 2). In three of the fatal (unilateral) cases (Nos. 2, 38, 41) the growth had extended through the sclerotic coat. In 13 the optic nerve was invaded, and in the remainder it is

* Reported in the Lancet, 1879, two years after operation. Mr. Hodges has informed us that the patient was alive and well nine years after operation.

uncertain whether the tumour was or was not confined to the eyeball. In not one of the cases known to have ended fatally, with the possible exception of No. 40, was the growth entirely intraocular; in a considerable proportion of the total number, however, the after-history of the case could not be obtained.

Interval between Discovery of Growth and Operation in Fatal Cases and Cases of Recovery.

In the six cases which are known to have been permanently cured the average time which elapsed between the discovery of the growth and the removal of the eyeball was 4 months. In 16 fatal cases the average interval was 14 months.

Site of Recurrent Growth.

Of 22 cases the tumour recurred in the orbit in 17. In the remaining 5, secondary growths were met with in the cranial bones, the throat, palate, and in one case, in which a post-mortem examination was made, in the brain and spinal cord.

On the Possible Shrinking of Eyes containing Gliomatous Tumours.

In two of our cases (Nos. 36 and 58) in which both eyes were diseased, one eye shrank. In Case 36 the *left* eye, which was shrunken, was removed and examined microscopically. As will be seen on reference to the tables, the appearances were suggestive, but not conclusive, of glioma. Shortly after removal of this eye its fellow became affected, and the ophthalmoscopic appearances were thought to indicate glioma. Unfortunately the after-history of this patient could not be obtained.

In Case 58 the *left* eye was shrunken; it was not removed; the *right* eye undoubtedly was affected by glioma.

It was removed; the child died soon after with cerebral symptoms, and there was a growth on one parietal bone.

Three cases are already on record in which eyes believed to be affected by glioma underwent shrinking.

SNELL, Ophth. Soc. Trans., vol. iv, p. 49, reports one case, and in the same vol., p. 54, BRAILEY reports one case.
BRAILEY, Ophth. Soc. Trans., vol. v, p. 61, reports a second case.

In Snell's case the shrunken eyeball was not examined microscopically. In Brailey's first case the report of the examination of the shrunken eye contains the following: "The microscope shows nothing that can be taken as indicating the existence of a glioma." In both instances the second eye undoubtedly contained a gliomatous growth (microscopic examination). In Brailey's second case neither eyeball was examined microscopically, but there is scarcely a doubt that the non-shrunken eye was affected by glioma.

It would seem, therefore, that the evidence that an eyeball containing a gliomatous growth may shrink is as yet inconclusive. Our case, No. 36, appears to be the most likely one recorded; the extreme difficulty of deciding by microscopic examination between a degenerating glioma and the degenerated structures of an eyeball destroyed by inflammation, tubercular or other, will be recognised by all who have had occasion to examine such specimens. The question is one of importance, and one which we hope may be settled before long.

We may here refer briefly to cases, and of two such we are cognisant, in which both eyeballs have been removed simultaneously for supposed glioma, and which subsequent examination proved not to be of that nature. It would seem advisable in such cases to remove one eye at a time, and subject it to examination before excising its fellow.

Family History.—Our endeavours to obtain reliable family history have been signally unsuccessful. What we

have obtained does not appear to be in any sense important. When known the facts are stated in the tables.

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
1	24	George C.	L	2	$3\frac{6}{12}$	—	Alive
2	236	Thos. J.	R	$2\frac{6}{12}$	4	5 or 6 months later	14 months
3	209	—	L	$1\frac{6}{12}$	3	—	A few days
4	65	—	—	1	$2\frac{6}{12}$	—	—
5	365	Alfred H.	L	doubtful	6	Less than 3 months	6 months
6	252	Mary M. B.	L	„	$\frac{4}{12}$	—	$2\frac{3}{12}$ years
„	„	„	R	1	$2\frac{2}{12}$	—	6 weeks
7	323	Bertie T.	L	$1\frac{3}{12}$	$2\frac{9}{12}$	—	—
8	382	Arthur G.	L	$2\frac{1}{12}$	$2\frac{10}{12}$	9 months later	14 months

*** Except when otherwise stated, the age is given in years.

We have had no instance in which more than one member of the family has suffered from glioma of retina.

9. Position and extent of primary growth.	10 Site of recurrent growth.	11. Family history.	12. Remarks.
Tumour growing from inner surface of retina, nearly filling vitreous chamber. O.N. not invaded. Growth entirely intraocular.	—	Negative. Patient was the third of five children, all living, 1890	No recurrence 19 years later, February, 1890.
Eyeball filled by new growth, which had perforated sclera. O.N. not invaded.	R. orbit, implication of glands behind jaw	Mother had a "growth" in nose; died, æt. 24, of an acute illness.	
Globe filled with growth which extended backwards along O.N. sheath.	—	Negative.	
Growth sprouting into vitreous, half filling it. O.N. not affected	—	Not known	After-history unknown.
Globe nearly filled by growth. O.N. probably invaded	L. orbit	,,	
No notes	—	Negative.	
Growth half filling vitreous nodule behind globe. O.N. involved	R. orbit	,,	
Extensive intraocular growth. O.N. deeply invaded	—	A third cousin died young of uterine tumour	After-history unknown. At date of operation had two or three enlarged glands under left angle of jaw.
Eyeball filled by growth. No perforation. O.N. probably involved	Unknown	Not known	Child became blind five months before death.

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
9	130	Florence G.	R	5 weeks	9 weeks	—	—
„	542	„	L	$1\frac{3}{12}$	$3\frac{6}{12}$	—	—
10	539	Thomas C.	R	$1\frac{10}{12}$	$3\frac{8}{12}$	Soon after	Uncertain, but death occurred soon
11	420	Arthur F.	R	—	$2\frac{6}{12}$	3 months	Unknown
12	307	Robert E.	L	$4\frac{10}{12}$	5	Less than 2 months	About 9 months
13	343	Eleanor P.	L	$2\frac{5}{12}$	3	—	—
14	258	James W.	L	6	$6\frac{6}{12}$	—	1 month

9. Position and extent of primary growth.	10. Site of recurrent growth.	11. Family history.	12. Remarks.
Growth nearly filling globe. O.N. invaded as far back as lamina cribrosa. Glioma exophytum	—	Negative but incomplete	No recurrence in R. socket 3½ years later.
Globe filled by growth. Retina and choroid disorganised, except anteriorly. Nerve invaded by glioma cells for "a little distance" from disc. Cornea invaded by growth and staphylomatous	—	—	After-history unobtainable.
Retina, O.N., and choroid all extensively involved. O.N. cut behind the posterior limit of the invading growth. Cornea affected by growth and staphylomatous	In socket	Negative	The left eye also became affected by glioma.
Globe filled by growth, which has invaded the O.N.	Orbit	Not known	After-history unknown.
Glioma mass in posterior part of vitreous cavity. Tumour cells invade O.N. Choroid not involved	„	Negative, as far as known.	
Tumour in posterior part of vitreous. Choroid not involved. No growth posterior to lamina cribrosa	—	Negative	After-history unknown.
Globe filled by tumour. Structures much disorganised. Tumour cells found in O.N.	—	„	Died with symptoms of intracranial disease. Injury to eye two weeks before growth was noticed.

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
15	257	Bertie H.	L	$1\frac{9}{12}$	$2\frac{6}{12}$	About 11 weeks	5 months
16	256	George G.	L	$4\frac{6}{12}$ "Eye squinted from birth."	5	—	Alive
17	162	Charlotte W.	L	$3\frac{6}{12}$	4	—	9 months
18	655	Ernest L.	L	$2\frac{1}{12}$	$2\frac{3}{12}$	—	—
19	615	George C.	L	$\frac{11}{12}$	$2\frac{3}{12}$	—	—
20	678	Annie A.	R	$1\frac{6}{12}$	2	Less than 3 months.	6 months
21	645	Samuel J.	R	Within 1 month of birth.	8 weeks	—	A few months
22	606	Lizzy B.	L	Eye "always blind."	3	6 weeks	6 months

9. Position and extent of primary growth.	10. Site of recurrent growth.	11. Family history.	12. Remarks.
Large growth projecting forward from O.D. and nearly filling globe. O.N. deeply invaded	Orbit and periosteum of cranial bones	Negative.	
Lower part of vitreous filled with new growth. Choroid free. O.N. invaded as far as inner surface of lamina cribrosa	—	Negative. Mother died of phthisis	In February, 1890, 11 years and 9 months after operation, patient reported by his father to be alive and well.
Mass of new growth near O.D. Choroid and O.N. both extensively involved	Orbit and cranial bones and throat	Brother has a "cancer on the instep of right foot"	Right eye became blind one week before death.
Circumscribed gliomatous growth in retina near O.D. and invading O.N.	—	Negative	Injury to L. eye by a fall off a chair, immediately before the growth was noticed. Child alive and well one year after excision. Further history unknown.
Vitreous cavity nearly filled by growth. Choroid involved	—	Paternal uncle died of phthisis	Second eye was also the seat of a glioma. It was not removed.
Rounded growth half filling vitreous cavity. O.D. cupped; tumour cells invade O.N. Choroid involved	Orbit	Negative	The left eye became blind shortly before patient's death.
Globe entirely filled by new growth. O.N. invaded by glioma cells	—	,,	The second eye was removed soon after, for a similar affection. Death soon ensued.
Large mass of new growth in orbit surrounding the O.N. Eyeball filled by growth which has invaded sclerotic	Orbit	Unknown.	

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
23	583	Henry P.	L	$3\frac{8}{12}$	4	—	Alive
24	447	Sarah L.	L	$1\frac{6}{12}$	2	2 months	$3\frac{1}{2}$ months
25	456	Julia H.	L	1	$1\frac{10}{12}$	—	—
26	810	Margaret C.	R	"At birth."	$1\frac{1}{12}$	—	—
„	1269	„	L	$1\frac{8}{12}$	$2\frac{7}{12}$	—	2 months
27	929	Henrietta K.	L	$2\frac{6}{12}$	$2\frac{6}{12}$	—	—
28	1045	Gertrude L.	L	$\frac{6}{12}$	2	—	3 weeks
29	1167	William G.	R	$1\frac{6}{12}$	2	—	Alive
30	1126	Conrad S.	R	$5\frac{8}{12}$	6	—	—

9. Position and extent of primary growth.	10. Site of recurrent growth.	11. Family history.	12. Remarks.
Globe filled by tumour, as far forward as lens. No trace of retina recognisable. O.N. probably not involved	—	Negative	Hydrocephalus in two brothers. Patient reported well (Feb., 1890) 14½ years after operation.
Tumour almost completely filled vitreous cavity. O.N. deeply invaded by gliomatous growth	Orbit	One paternal aunt died of "tumour of breast."	
Large growth almost filling vitreous. O.N. close to eye-ball invaded by glioma cells	—	Phthisis in father's family.	Further history unobtainable.
Eye almost full of soft gliomatous growth	—	Unknown	
Globe filled by glioma; A.C. partly occupied by growth. O.N. apparently not invaded	—	,,	
Tumour occupies upper, inner, and lower portions of vitreous cavity	—	,,	After-history unknown.
Large mass of growth; choroid and O.N. extensively involved	—	Negative	At time of operation there was a lump in the palate, which rapidly increased, and a growth appeared over left brow.
Large flocculent mass of growth. Retina affected in nearly whole extent. No note of condition of O.N.	—	,,	Patient seen Feb. 21, 1890 ($5\frac{8}{12}$ years after operation). Is in good health.
Large growth filling three-quarters of vitreous cavity. O.D. infiltrated. O.N. at cut surface apparently normal	—	Unknown	After-history unknown.

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
31	1200	Lottie S.	R	2	$2\frac{8}{12}$	—	2 months
32	1259	Isabella S.	L	5	6	—	—
33	1264	Rose H.	R	$5\frac{5}{12}$	6	—	About 3 years
34	783	Ebenezer S.	L	$\frac{10}{12}$ "Always different to other eye"	$\frac{11}{12}$	—	—
„	1293	„	R	$1\frac{11}{12}$	$2\frac{9}{12}$	—	"A very short time"
35	1309	Charlotte A.	L	$1\frac{4}{12}$	$2\frac{2}{12}$	Less than 1 month	9 months
„	1339	„	R	At time of excision of L.	$2\frac{3}{12}$	—	8 months
36	1312	James R.	L	—	$\frac{9}{12}$	—	—

9. Position and extent of primary growth.	10. Site of recurrent growth.	11. Family history.	12. Remarks.
Very large extraocular nodular growths. Globe full of gliomatous growth. O.N. much thickened	—	Negative.	
Soft nodular growth, filling posterior two-thirds vitreous chamber. No note about O.N.	—	Unknown	History of blow on left eye one year before operation. Sight said to be "lost" by doctor immediately after injury. Subsequent history unobtainable.
Friable growth, retina nearly all indistinguishable, choroid not involved. No note about O.N.	—	Negative	Exact date of child's death unknown; it is known that she died.
Tumour of lower part of retina. Choroid *in situ*	—	,,	
Large fungating pink mass projecting from anterior part of eye. Globe full of growth. O.N. invaded	R. Orbit	,,	Exact date of death unknown.
Globe completely filled by growth. Large extraocular mass posteriorly, in which O.N. was involved	Orbit	Unknown.	
Globe filled by gliomatous growth. O.N. slightly enlarged	—	,,	
Globe shrunken; central part filled by degenerated tissue, like gliomatous growth. Evidence of choroidal inflammation; cells in O.N. probably inflammatory	—	Negative	Ten days after operation the right eye was found to be affected with glioma. After-history unknown.

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
37	1460	Thomas C.	R	$3\frac{3}{12}$	4	—	—
38	1782	Ernest L.	L	$\frac{9}{12}$	4	—	4 months
39	1816	George C.	L	—	$4\frac{6}{12}$	—	Alive
40	1875	Lilly D.	R	—	$1\frac{6}{12}$	—	8 months
41	2013	Walter M.	L	$\frac{3}{12}$	1	6 weeks	10 weeks
42	2191	Rose H.	L	4 days	4 weeks	—	—
43	2233	Rose C.	L	6	6 years	—	Alive
44	2393	Ada D.	R	$2\frac{9}{12}$	3	—	10 months
45	2408	Ellen E.	L	"At birth"	$1\frac{7}{12}$	—	Alive

9. Position and extent of primary growth.	10. Site of recurrent growth.	11. Family history.	12. Remarks.
Retina almost completely detached. Largish triangular mass of growth invading O.N. at disc, but cut surface apparently healthy	—	Unknown	After-history unobtainable.
Globe filled by tumour; two nodules on anterior surface of sclerotic near corneal margin. O.N. not involved	—	Negative.	
New growth fills about one-third vitreous cavity. Several separate nodules of growth, one springing from the O.D.	—	Unknown	In Dec., 1889, 4 years 7 months after operation, child reported alive and well.
Nodules of new growth on retina, latter detached from choroid except at O.D.	—	,,	
Eyeball full of new growth and a large mass at posterior surface. O.N. surrounded by growth but apparently not involved	Orbit	Negative.	
Vitreous chamber filled by new growth	—	Phthisis on mother's side	Subsequent history unknown.
In lower part of retina; latter detached	—	Negative	In July, 1890, 3½ years after operation, the child was alive and well.
Eyeball filled by tumour. O.N. involved	Orbit	,,	
Tumour fills three-quarters of vitreous chamber. O.N. apparently intact	—	Unknown	In Oct., 1890, 3 years 1 month after operation, child alive and well.

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
46	2482	Lawrence L.	L	—	$\frac{7}{12}$	—	Alive
47	1838	Amy S.	L	$1\frac{10}{12}$	2	—	—
48	2527	Florence A.	R	—	$\frac{8}{12}$	—	—
49	2764	Charlotte H.	L	$4\frac{6}{12}$	5	3 months	4 months
50	2768	Sidney R.	R	$\frac{4}{12}$	$\frac{5}{12}$	—	Alive
51	2824	Alice T.	L	$1\frac{9}{12}$	$2\frac{6}{12}$	4 months	6 months
52	2865	George H.	R	1	2	Less than 3 months	8 months

9. Position and extent of primary growth.	10. Site of recurrent growth.	11. Family history.	12. Remarks.
A rounded mass of growth in nasal half, and a small separate nodule on temporal side springing from retina. O.N. not involved	—	Unknown	In Nov., 1890, 3 years after operation, child alive but imbecile. The right eye had been removed by Mr. Gunn at æt. 2 months, and contained a large glioma-tous growth.
Tumour almost entirely fills vitreous chamber; retina detached and pushed forwards. Growth invades O.N. as far as lamina cribrosa, and has spread to choroid in places	—	Negative	After-history unobtainable.
Large flocculent mass in vitreous cavity and between retina and choroid. Choroid and O.N. invaded by growth	—	Unknown	After-history unobtainable.
Globe entirely filled with soft new growth. O.N. invaded by glioma cells. Choroid intact	Orbit	Negative	At the post-mortem secondary growths were found in the brain and spinal cord.
Growth occupies two-thirds vitreous chamber. O.N. infiltrated by tumour cells	—	,,	June, 1890, 17 months after operation, child alive and well.
Growth filled five-sixths vitreous chamber. O.N. apparently not involved	Forehead	,,	Sight of the second (R.) eye was said to have been lost shortly before death.
Tumour growing from retina fills two-thirds vitreous chamber. Choroid attacked by the growth. O.N. extensively invaded by tumour cells	Orbit	Unknown.	

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
53	2938	Philip B.	R	$\frac{6}{12}$	$3\frac{6}{12}$	—	—
54	2999	Ellen W.	L	$\frac{3}{12}$	$\frac{4}{12}$	—	—
55	Mr. Morton's case.	Julia T.	R	$\frac{3}{12}$	$\frac{5}{12}$	—	Alive
,,	,,	,,	L	$1\frac{2}{12}$	$1\frac{2}{12}$	—	,,
56	Mr. Square's case	Wilmot J.	R	$6\frac{9}{12}$	7	—	,,
57	Mr. Jessop's case	Minnie T.	L	$\frac{9}{12}$	$1\frac{9}{12}$	—	,,
58	Mr. Gunn's case	Arthur C.	R	—	2	—	Unknown

9. Position and extent of primary growth.	10. Site of recurrent growth.	11. Family history.	12. Remarks.
Large soft growth half filling vitreous chamber, detaching retina. O.N. apparently infiltrated	—	Unknown	Further history unobtainable.
Growth from outer surface of retina filling two-thirds of globe. O.N. apparently not invaded	—	Negative	7 months after operation child alive and well.
Growth in posterior part of vitreous chamber. Retina much disorganised. Cells of new growth at anterior surface of lamina cribrosa	—	One brother died of "consumption" in early life.	
New growth fills about one-third of the vitreous chamber; it is within the retina. O.N. invaded by glioma cells	—	—	In Nov., 1890, 2 years 2 months after operation on second eye, child alive and well.
Large growth from retina invading choroid and sclera at lower part, and giving rise to rounded swelling	—	Negative	In Feb., 1890, 1 year 10 months after operation, child alive and well.
Globe nearly filled by new growth. Retina partially detached. O.N. infiltrated with glioma or inflammatory cells	—	,,	The eye was noticed to squint at æt. 6 months. In Nov., 1890, 2 years 4 months after operation, child alive and well.
Globe full of new growth, which had perforated sclera posteriorly. O.N. extensively affected	—	Unknown	Child died soon after removal of R. eye. The L. eye was blind and shrunken (? glioma). Malignant growth over parietal bone before removal of right eye.

1. No. of case.	2. Reg. No.	3. Name.	4. Eye affected.	5. Age when growth first noticed.	6. Age at date of operation.	7. Date of first symptom of recurrence.	8. Duration of life after operation.
59	3059	Fredk. J.	R	$2\frac{6}{12}$	$3\frac{3}{12}$	—	—
60	Mr. Lawford's case	Fleming C.	R	8 weeks	8 weeks	—	Alive 12 months after

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9. Position and extent of primary growth.	10. Site of recurrent growth.	11. Family history.	12. Remarks.
Soft tumour involving large part of retina. Islands of tumour cells in vitreous. O.N. not involved	—	Negative	No recurrence 9 months later (Nov., 1890).
Large soft growth springing from retina and filling vitreous chamber. O.N. apparently not involved	—	Grandfather died "cancer," æt. 55. One uncle died of phthisis	Glioma in left eye, discovered 9 months after operation on right. Probable growth in frontal bone on right side.

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NOTE ON FÖRSTER'S ARTIFICIAL RIPENING OF CATARACT.

By J. Tatham Thompson, M.B.,

Ophthalmic Surgeon to the Cardiff Infirmary, &c.

Early in March, 1888, three patients were attending the out-patient clinic of the Cardiff Infirmary, suffering from cataract of both lenses. In all these cases the opacity was practically equal in the two eyes, very slowly advancing, and yet the vision so much reduced that the usual employment could not be followed.

The first patient, P. D., æt. 57, a gardener. Vision, R.L., about $\frac{10}{200}$, double cortical cataract, not well-marked striæ.

No. 2. F. J., æt. 51, a coal trimmer. Cataracts "mixed" in character, a marked general haze, with sharply-defined peripheral striæ. Vision, $\frac{20}{200}$.

No. 3. A female, Mrs. W., æt. 55, a housekeeper. Her sight had been gradually failing for the last three or four years. Still able to read large print with effort. The opacity was greatest centrally, but her vision was only slightly improved by full dilatation of the pupil. No glycosuria.

I resolved to perform preliminary iridectomy in each of the cases, and to try and hasten maturation by Förster's method of applying friction to the lamellæ of the lens.

All these cases were operated on at the same time, a small iridectomy being performed upwards, most of the aqueous allowed to escape, and then friction applied in a semi-rotatory manner by means of a silver spatula applied to the cornea, which was kept constantly moistened with boracic-acid lotion. The friction was applied for three or four minutes.

The dressings were changed in 24 hours—in Case No. 2 there were some signs of iritic irritation, and atropine was

instilled—the other two were simply dressed again with antiseptic absorbent compresses.

Seven days after the operation, the "ripening" process was evident in all three cases. No. 1 could only count fingers at 6 feet. No. 2, vision reduced from $\frac{20}{200}$ to $\frac{10}{200}$. No. 3, vision only slightly reduced, but she was now unable to read the large type with the eye operated on. The threatened iritis in No. 2's case had quite disappeared.

Within four weeks from the time of the first operation, the lenses were extracted in the case of the two male patients.

In No. 1 the lens was fairly hard, and came away very cleanly and completely. In No. 2 there was a certain amount of soft lens substance which had to be coaxed out after waiting a few moments for more aqueous to collect. Both cases did well.

A week or two ago I had an opportunity of testing the vision of No. 1. With +10D., V. = $\frac{20}{20}$; with +15, he read Jaeger 1.

In Case 2 vision was good, $\frac{20}{30}$; patient illiterate.

In the third case a somewhat unexpected result was arrived at. For the first four weeks the maturation apparently went on steadily till the vision was reduced to the possibility of counting fingers at 3 or 4 feet. Then to her and my own great astonishment, her vision began to improve. I watched the case from week to week, and found the lenticular opacity slowly clearing up from without inwards; this went on until at the present time she is doing her housekeeper's work, relying on that eye. There is only a trace of granular opacity, apparently at or near the nucleus of the lens. With presbyopic correction she reads moderate-sized print with comparative comfort.

In the meantime the cataractous condition of the other lens has very slowly advanced.

In Case No. 1, the left eye was treated in the same manner 12 months after the right eye was operated on. The lens was extracted in about four weeks after the Förster operation; it was, however, more advanced towards maturity before this than had been the case in the right eye.

I have at various times, since the occasions mentioned, adopted Förster's method, and with varying success; but on no other occasion did any clearing-up take place. Several times there appeared to be very little hastening of the ripening process.

In two cases only had I any difficulty; in these a sub-acute iritis was set up; there was, however, no reason to hink that the final result was in any way less successful on that account.

ON THE PATHOLOGY OF INTRAOCULAR CYSTS.

By E. Treacher Collins,

Curator of the Museum.

In a paper on cysts of the iris, published in 1867,* Mr. Hulke, after drawing attention to the frequency with which they are associated with penetrating wounds of the cornea, suggested, "that in some instances, perhaps, the cyst may originate out of a portion of Descemet's membrane, which may have been torn away from the back of the cornea by the penetrating foreign body and carried before it into the iris." Having collected a large number of recorded cases, he showed that there are four varieties of cysts of the iris :—

"1. Delicate membranous cysts, with an epithelial lining and clear limpid contents.

"2. Thick-walled cysts, with opaque thicker contents.

"3. Solid cystic collections of epithelium, wens or dermoid cysts.

"4. Cysts formed by deliquescence in myxomata."

Rothmund,† in 1872, in treating of the same subject, mentioned three cases in which a growth on the iris resulted from an eyelash being carried into the anterior chamber. He also stated that cysts might arise from portions of skin or of the epithelial coating of the eye carried in, in the same way.

Monoyer‡ pointed out that the term cyst was inapplicable to the solid growths on the iris, which he found were composed of concentric layers of epithelial cells. He prefers the name "epithelial pearl tumour of the iris," a name originally applied by Virchow to similar growths in

* Ophth. Hosp. Rep., vol. vi, p. 12.

† Klin. Monatsb. f. Augenheilk., vol. x, 1872, p. 191.

‡ Annales d'Oculistique, 1872, p. 249.

other parts of the body. The term cholesteatoma, suggested by Müller, has also been used for them.

Masse,* in 1881, experimented on rabbits, introducing into their anterior chambers through an incision in the cornea and grafting on the iris small pieces of conjunctiva and skin, and subsequently in 1883 bits removed from the surface of the cornea. From these grafts he has found develop both epithelial pearl tumours and true cysts.

Implantation-cysts which are spoken of as dermoids of the limbs have been found following such slight injuries as pricks of the finger with a needle. These cases and some of cysts occuring in animals, the results of prods in the side with the sharp iron spike used by cattle drovers, have been collected and described by Mr. J. Bland Sutton.†

That cysts the result of implantation of epithelial cells, should occasionally occur in the substance of the cornea itself, as well as in the anterior chamber or on the iris, is what might be expected, and is demonstrated by the following two cases:—

Case 1 (*Register No.* 2983).—*Epithelial Implantation-Cysts in the Cornea following a Perforating Wound with a Shot.*

John C., aged 27, was admitted under Mr. Tay, at the Moorfields Hospital, on June 22, 1887, with the history of having been wounded in his right eye and right lower lid by a shot 18 months previously.

On examination of the right eyeball after removal it was found to be shrunken, measuring only 18 mm. antero-posteriorly, and 19 mm. laterally. There were puckers in the sclerotic behind the insertion of the recti muscles. The cornea was small, measuring 8 mm. laterally and 4 mm. vertically. There was a depressed cicatrix at its upper part. After the eye had been hardened and opened by an anteroposterior vertical section, the lens was found to be absent, the retina detached everywhere except at the optic disc and the ora serrata; it formed a

* Gaz. d'Ophth., Paris, 1881, p. 275. *Ibid.*, 1883.

† Hunterian Lectures, Royal College of Surgeons, 1889.

thick plicated cord in the centre of the globe. No foreign body was discovered in the eyeball.

Microscopical examination shows in one section at the seat of the cicatrix in the cornea a collection of epithelial cells continuous with the surface epithelium dipping down into its substance. Other sections show several isolated clumps of epithelial cells, some of them quite deeply situated in the fibrous tissue of the cornea. The larger of these patches have spaces in the centre of them, which contain a few streaks of a sort of hyaline substance; probably the coagulated remains of the fluid contents of these cysts (Fig. 1). On careful examination of the cells composing these patches of epithelium, the outermost are seen to be the largest and most perfect, the inner ones being more flattened.

FIG. 1.—Section of a portion of the cornea from Case 1, showing spaces surrounded by epithelial cells in its substance.
c, Cyst. *d*, Descemet's membrane. *u*, Uveal pigment of iris.

In sections stained with picro-carmine the outer layers of cells in the patches above mentioned are of a red colour, and the inner ones of a yellow.

It is doubtful if these isolated clumps of epithelium are entirely separate collections or only processes cut off the main mass seen dipping in.

Case 2 (*Register No.* 2889).—*Epithelial Implantation-Cyst in the Cornea in a shrunken Eye after Extraction of Cataract.*

Titus J., aged 25, was admitted into Moorfields Hospital under Mr. Lawson, on June 10, 1889. He had been operated on for cataract 12 months previously elsewhere. He had not had any sight in the eye since. He stated that the eye was spoilt on account of his having vomited after the operation, on recovery from the anæsthetic which had been administered to him. The eyeball after enucleation was found to be much shrunken, the sclerotic puckered, and the cornea very small. On section the choroid was found detached from the sclerotic on one side, some yellow-coloured tissue filling the space between. The lens was absent. The whole interior of the globe was filled with folded retina.

Microscopical examination of the cornea shows a number of patches of small round cells between its fibres, which are very irregular. There are numerous blood-vessels in the superficial layers. In its centre is a large cyst lined by several layers of epithelial cells. This cyst is quite separate from the surface epithelium. There is a second smaller clump of epithelial cells, without, however, any central cavity in it. Some streaks of a hyaline substance are seen in the interior of the cyst (Fig. 2).

The way in which the cysts in the above cases have been formed is evidently as follows. At the time of the injury, the entrance of the shot in Case 1, and the puncture with cataract knife in Case 2, some of the epithelial cells from the surface of the cornea have been transplanted into its substance, and have there proliferated. As they have increased in numbers, the central ones have become much pressed upon, and consequently have broken down and liquefied.

As can be easily imagined, the firm tissue of the cornea would offer considerable resistance to the proliferating cells, and consequently there would be little

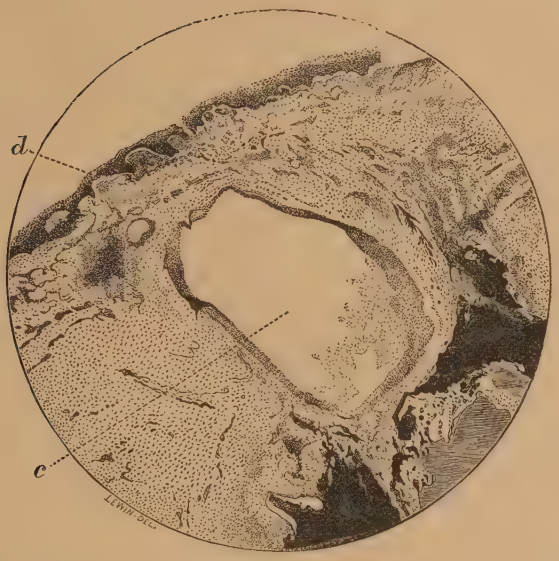


FIG. 2.—Section of shrunken cornea in Case 2, showing a cyst in its centre lined by epithelial cells.

c, Cyst. *d*, Descemet's membrane.

tendency for the cysts to expand, and the central breaking down would take place early. On the surface of the iris, however, very little pressure would be exerted on the grafted cells, and the resulting tumour would be more likely to take on the character of a solid growth composed of laminated layers of epithelium. In the substance of the iris more resistance again would be experienced, and more likelihood of central degeneration and liquefaction.

Masse obtained cysts as well as epithelial pearl tumours by transplantations into the rabbit's anterior chamber. It would seem, then, that epithelium when thus transplanted may behave in one of two ways. It may either cornify, as it does on the surface of the skin, and thus form a laminated tumour, or the cells may break

down and liquefy after having reached a certain stage of development, as they do physiologically on a secreting surface, and thus form a cyst with fluid contents.

The nature of the contents of these implantation-cysts would vary with the nature of the implanted epithelium.

Supposing some of the epidermis to have been engrafted together with some cells from a sebaceous follicle, we should expect a sebaceous cyst to result. Graefe* has described a case in which the cyst was found to contain short hairs and sebaceous matter. One recorded by Strawbridge† "was lined with a layer of squamous epithelial cells, swollen, and in an advanced stage of fatty degeneration. These cells were free from each other, and were surrounded by granular matter, fat, and cholesterine crystals." In Snell's case‡ the contents of the cysts is described as consisting of "a number of very large, clear, closely-packed cells, like fat cells, in which no nucleus was discernible, of cholesterine crystals in great numbers, of a large quantity of fatty matter, both in the purely granular and oily forms, of pigment cells and granules in small quantity, of sparsely scattered tessellated epithelium, and of a homogeneous finely granular material."

If the epithelium of the conjunctiva be implanted, we should expect a cyst with mucoid contents. Richard§ described a two-lobed cyst of the iris of opal blue colour, containing a gelatinous liquid. In Turner's‖ and Fewer's¶ cases the contents were spoken of as partially turbid.

Regarding some of the cysts of the iris as resulting from implantation of pieces of epithelium, it is not surprising to find that occasionally they are multiple;

* Archiv f. Ophth., III, 2, p, 412.
† Trans. Am. Ophth. Soc., 1878, p. 385.
‡ Ophth. Hosp. Rep., vol. x, p. 208.
§ Gaz. Hebdom, T. i, 1082.
‖ Monthly Journal of Med. Sciences, vol. i, p. 270, 1841.
¶ Klinische Monatsb. f. Augenheilk., 1873, p. 110.

that they re-form after simple puncture, and that they recur after attempts at removal.

Thus Knapp* reports a case in which "the cyst originated in a scar from a foreign body in the vitreous. Six years after the successful removal of the foreign body the cyst made its appearance. It was cut out, but returned about a year later. It was removed again. The operation was rather a desperate one with forceps and scraping hook." Ultimately the case did well.

Critchett† has published a case in which a portion of the cyst was in the anterior chamber, and a portion sub-conjunctival, shaped like an hour-glass. The pathological examination of the cyst made by Brailey is given; there were several layers of flattened epithelial cells on its inner wall.

Sattler holds a different view to the one above given as to the manner in which detached portions of epithelium introduced into the anterior chamber give rise to cysts. He considers that the continued pressure of a foreign body gives rise to irritation, and stimulates to increased activity the surrounding tissues, so that the interstices of the iris become enlarged by serous exudation, and thus an interspace filled with serum formed. He would class them as exudation cysts. This view leaves unexplained the lining of several layers of epithelial cells found on their inner surface.

There are very few cases of cysts occurring in the cornea recorded, and as far as I have been able to ascertain none similar to the two above mentioned. Alt‡ describes four eyes in which he found cysts in the parenchyma of the cornea, in all of which there had been a perforating wound. In two, the cysts were lined by uveal pigment; he thinks that some particles of uvea were carried into the corneal wound at the time of per-

* Trans. Am. Ophth. Soc., 1880, p. 104.

† Ophth. Hosp. Rep., vol. ix, p. 53.

‡ Arch. of Ophth. and Otol., 1878, vol. vi, p. 317.

foration, and then proliferated and destroyed the surrounding corneal tissue. Of the other two, one had perfectly smooth walls, and the other a number of trabeculæ passing from one to the other. In neither is any mention made of a lining of epithelium. He thinks most probably these cysts were the result of corneal abscesses.

Samelsohn* has also recorded a case of cyst in the substance of the cornea, which on a puncture being made into it gave exit to a clear liquid. No microscopical examination was made. Small cysts or vesicles on the surface of the cornea are met with most commonly in staphylomatous or old glaucomatous eyes; probably in these it is only a later and more extreme degree of the condition described by Fuchs† as giving rise to the corneal haze in glaucoma. Case 3 and Fig. 3 illustrate the condition in a very marked manner.

Some of the projections that form on the surface of the cornea, and look like vesicles, are not, however, of this nature, and can hardly be described as cysts or vesicles at all. They appear to be small protrusions of an œdematous fibrous tissue. Case 4 demonstrates this.

Case 3 (*Register No.* 2687). *Anterior Staphyloma with Vesicles in the Corneal Epithelium.*

James D——, aged 4, was admitted to Moorfields Hospital, under Mr. Tweedy, in August, 1888, with a large prominent anterior staphyloma of his right eye, T.+2, and a nebula of his left cornea. His eyes had been bad since infancy, probably as the result of ophthalmia neonatorum.

The right eye was enucleated.

Pathological Examination.—Cornea is much enlarged and thinned; it has an irregular mottled opacity on it superficially. Its posterior surface is lined by a network of the uveal pigment of the iris. There is considerable bulging in the ciliary region, especially above. The ciliary processes and muscle are much stretched and atrophied. The lens is absent; a small fibrous

* Klin. Monatsb. f. Augen., 1872, p. 310.

† Archiv f. Ophth., xxvii, 3, p. 66.

nodule on the uveal pigment at the back of the cornea shows the position of the remains of its capsule. The choroid has several large patches of atrophy in it with deeply pigmented margins. The optic nerve is cupped.

Microscopical Appearances of the Cornea.—There is a small amount of round cell infiltration between the most anterior layers of the cornea. Its epithelial layer has a large number of cystic spaces in it of very various sizes, mostly of an oval shape. Some of these spaces have their anterior walls ruptured, and open on the surface. All of them are separated by a layer of cells from the anterior elastic lamina of the cornea. The posterior surface of the cornea is lined by uveal pigment; neither the endothelium of Descemet's membrane, nor any of the stroma of the iris can be distinguished (Fig. 3).

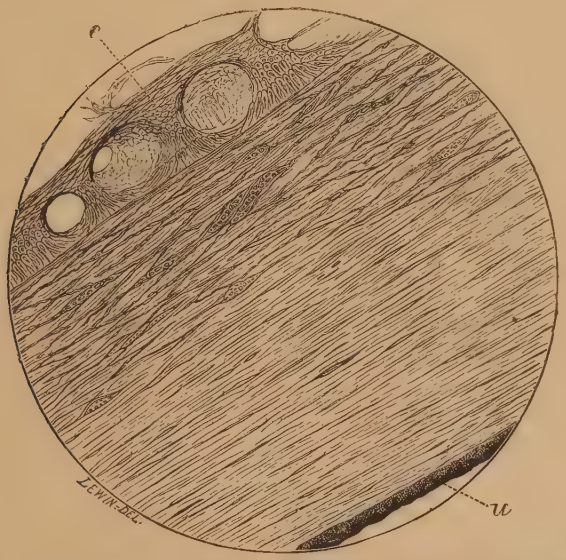


FIG. 3.—Section of cornea from Case 3, showing vesicles in its anterior epithelium.

e, Epithelium. *u*, Uveal layer of iris.

Case 4 (*Register No.* 3039). *Spurious Vesicles of Cornea.*

William A——, aged 20, was admitted under Mr. Streatfeild, to the Moorfields Hospital in March, 1881, with well marked hereditary syphilitic kerato-iritis in both eyes. Both corneæ were bulged forwards and had diffuse interstitial deposit throughout. There were total posterior synechiæ and a condition of bombé iris on both sides. The tension of the left eye was +. Iridectomy was twice performed on this eye.

In January, 1890, the patient came complaining that during the last few months his left eye had rapidly increased in size and become very painful. It was then excised.

Pathological Examination.—Antero-posterior diameter measures 32·5 mm.; lateral, 25 mm.; vertical, 23 mm. The portion of the globe in front of the recti muscles is extremely staphylomatous. The cornea is much enlarged, opaque, and of a bluish colour. On its surface are several small vesicles; the two largest measure respectively 4 mm. × 3 mm. and 8 mm. × 4 mm. The thickness of the cornea is uniform, but thinner than normal. The iris is adherent to the posterior surface of the cornea throughout the greater part of its extent, the pupillary margin being the only part free. It is much atrophied. The lens is healthy. Vitreous shrunken. The choroid has large patches of atrophy in it; in these situations the retina is adherent to it.

Microscopical appearances of the cornea:—

Sections passing through the vesicles above mentioned show them to consist of a loose irregular network of fibres, with angular branching cells and covered on the surface by epithelium. Where they join the cornea they become constricted, the epithelium dipping down into the constriction. Thus in sections passing near to one side of a vesicle, there appears to be a small mass of loose fibrous tissue separated entirely from the rest of the fibrous tissue of the cornea by a layer of epithelium. The anterior elastic lamina cannot be traced in the neighbourhood of the vesicles (Fig. 4).

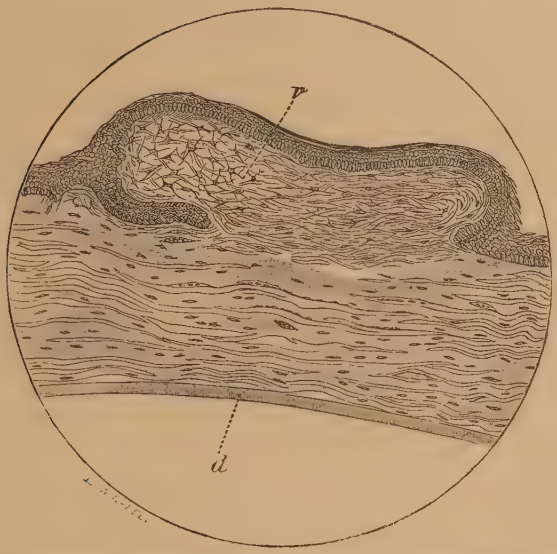


FIG. 4.—Section of cornea in Case 4, showing a localised collection of œdematous fibrous tissue on its anterior surface.
v, Spurious vesicle. *d*, Descemet's membrane.

The first class of iris cysts mentioned by Mr. Hulke in the article before referred to are probably not implantation-cysts. They are, he says, "delicate membranous cysts with an epithelial lining and clear limpid contents." The cells lining them are arranged in the form of a single pavement layer; thus differing markedly from his second class in which the cells are several layers deep. These cysts might be termed *endothelial cysts*, and the others *epithelial cysts*, for the former I believe arise entirely from mesoblastic structures, while the latter are due to implantation of epiblastic tissue into subjacent mesoblast.

The endothelial cysts occasionally follow an injury to the eye, by no means necessarily a perforating wound. At other times they appear to arise spontaneously, as in the following case, of which Mr. Nettleship gave me the specimen to examine microscopically, and has kindly permitted me to record my results.

Case 5.—*Serous Cyst of Iris. No History of Injury to the Eye.*

Fanny P., æt. 44, was admitted to St. Thomas's Hospital on July 18th, 1889. She stated she had always had good sight until the previous summer, when she noticed some slight irritation in her left eye. Nothing was observed abnormal until September, when a small black, half-moon shaped speck appeared at the outer margin of the iris. In the mornings a little redness near this part of the eye was noticed, which passed off, however, when she had been out in the air some little while. The eye felt uncomfortable—a little pricking sensation in it from this time. Occasionally it watered. The light or the heat of the fire always made it seem worse. The speck has gradually increased in size. She has never had any actual pain. Has never had any injury to the eye. She has always been strong and healthy, never laid up with any serious illness. Her father died of heart disease; there is no history of rheumatism, cancer, or gout in her family.

Patient is quite healthy; there is no disease of any organ. Heart and lungs are normal. Urine, sp. gr. 1017; no albumen.

In her left eye, downwards and inwards, at the ciliary border of the iris is a small ovoid swelling of a black colour, about $4\frac{1}{2}$ mm. long by 4 mm. broad; the edge is sharply defined. It is protruding from the iris into the anterior chamber. All the lower part of the eyeball is slightly congested, and around the margin of the tumour is a small patch of ciliary congestion. There is tenderness at this spot. The pupillary margin of the iris in the neighbourhood is bulged, but otherwise normal. V. $= \frac{6}{12}$ Hm. $\cdot 5\,\frac{6}{6}$ partly. By focal light the walls of the cyst are seen to be translucent, and at its outer margin some fibres of the iris appear to be stretched over it. The posterior wall seems to be thinnest at its upper part, and some light can be transmitted through it.

On July 19th, the patient being under an anæsthetic, two incisions were first made through the cornea with a Taylor's knife; one just above the upper margin of the cyst, and one below its lower margin. These two incisions were then joined

by means of a secondary knife. At this stage the cyst ruptured. The iris with the cyst then prolapsed through the wound, and was cut off; the cut ends of the iris were replaced.

On July 23rd it was noted that the anterior chamber had re-formed, and that the eye was doing well.

Microscopic examination of the portion of iris and the cyst which were removed showed the following conditions:—

The cyst is situated nearer the anterior than the posterior surface of the iris. It is entirely in front of the uveal layers, some of the iris stroma intervening between its posterior wall and them. There is also a small quantity of stroma in front of the anterior wall of the cyst. It is lined with a layer of flattened endothelial cells, resting on a very distinct basement membrane. This latter is best seen on the posterior wall, where it stands out as a sharply-defined bright line, and on examination with high powers can be seen to be composed of closely packed nucleated fibres. The layer of cells on its inner surface in some places is composed of only a single layer. In other parts several layers are seen. This appears to be due to the cyst having become folded in places, and cut obliquely so as to show the lining epithelium on the flat.

CASE 6.—*Cyst growing from the upper part of the Iris. Probably of similar nature to that in the previous case.*

Mary W., aged 18, was admitted to Moorfields Hospital under Mr. Hulke, on November 24th, 1884. For the previous fortnight she had noticed a slight aching around the right eyeball, but had had no severe pain. Seven days ago a companion had noticed a growth at the upper portion of the eye. She had never observed that the sight of her right eye was not so good as that of her left. She had never had any injury to the eye.

On examination, a small ovoid cystic-looking swelling, measuring $3\frac{1}{2}$ mm. by 4 mm., was seen occupying the upper portion of the angle of the anterior chamber. The swelling was translucent, and the iris-tissue could be seen through it. The radiating fibres of the iris were best seen at the sides, but there was a faint longitudinal striation over its anterior surface also. There was a slight depression in its lower extremity. In the cornea over the cyst was a white line resembling a cicatrix.

V. = R. $\frac{6}{36}$ c̄ + ·75 cy. axis 40° down and in = $\frac{6}{12}$; L. $\frac{6}{6}$ Hm. ·75 $\frac{6}{6}$ and Ji.

On November 26th, under an anæsthetic, a corneal incision was made upwards with a Graefe's knife, and the cyst and a portion of adjacent iris drawn out and cut off. A piece of the cyst remaining behind was removed by a Tyrrell's hook.

Schmidt-Rimpler* has recently written on this class of cysts; he gives the details of a case in which there had been no perforating wound. "He considers that such cysts originate in the closure of one of the crypts always present in the iris. These crypts, according to Fuchs, dip into the iris tissue as deeply as the position of the vessels, and from the latter the lymph streams pass through them to the anterior chamber. These lymph streams have been demonstrated by experiments with fluorescin injection in rabbits (Schick). Anatomical researches, and especially the examination of the anterior surface of the iris by Zehender's binocular lens, have shown that these pits in the iris are frequently bridged over in front by bands, or completely by a thin membrane. In one instance, Fuchs observed (microscopically) a fine non-nucleated membrane closing the opening of a crypt.

"It seems legitimate to assume that such a membrane might become thickened as a result of disease, and thus the anterior outlet of the crypt be occluded; the same pathological conditions might block any lateral communications between the crypt in question and adjoining ones, and the lymph would then be unable to escape into the aqueous. The gradual accumulation of this secretion would soon lead to dilatation of the cavity so formed, and its encroachment on the surrounding iris tissue. The endothelial lining membrane of the cyst, Schmidt-Rimpler thinks is derived from the endothelium which dips into

* Arch. f. Ophthal., vol. xxxv, p. 1.

the crypts from the anterior surface of the iris. Under the irritation of the enclosed lymph, growth of this normally existing endothelial layer occurs; and this lining membrane is thickest on the posterior wall of the cyst."*

In the two foregoing cases, the cysts, it will be noticed, commenced to grow in the periphery of the iris, that is, in the portion described by Fuchs† as the marginal zone of the ciliary portion, the characteristic of which is the number of apertures on its surface which gives it a sieve-like appearance. This would then have been the part of the iris in which *a priori* it would have been expected that a cyst might arise in the way described by Schmidt-Rimpler. Beneath the endothelium on the anterior surface of the iris, there is what Fuchs describes as an extremely fine boundary line. This, under the irritation caused by the distention of retained secretion, has, in Case 5, become thickened and given rise to the basement membrane.

De Wecker speaks of a form of cyst occurring in the anterior chamber after penetrating wounds, in which there has been an infolding of the iris and the formation of an anterior synechiæ. The cavity thus shut off becomes distended by the secretion of aqueous fluid. Knapp‡ and Alt§ have met with cases of a similar nature. The formation of a horseshoe-shaped posterior synechia, and following on that a localised condition of bombé iris, gives rise to a condition of things often indistinguishable clinically from a cyst in the substance of the iris. The following is a case in point:—

Case 7 (*Register No.* 2983.) *Localised Condition of Bombé Iris simulating a Cyst of the Iris.*

Charles P., aged 19, admitted to Moorfields Hospital on October 17th, 1889, under Mr. Tay. Five weeks previously his

* See Abstract in Ophth. Rev., vol. viii, p. 372.
† Archiv f. Ophth., vol. xxxi, p. 39.
‡ Archives of Ophth. and Otology, vol. i, p. 411.
§ Lectures on the Human Eye, p. 94.

left eye had been injured with a chip of iron, while he was employed at his occupation of boiler making. A chip was removed at the Colchester Hospital. He had been unable to see with the eye since the accident. It was a perfectly good eye previously.

On examination of the eye, the cornea was found to be vascular at the lower part. There was a linear opacity in it, starting at the sclero-corneal margin down and in, and running upwards and slightly outwards. It started superficially, and then became deep, having some layers of clear cornea in front of it at the upper part. It terminated about the centre of the prominent portion of the iris.

The lower part of the iris was of a dull yellowish-grey colour: at the upper part was a dark prominence with a scalloped margin below; on the surface of this prominence the striated fibres of the iris could be seen. It was not translucent. No reflex could be obtained, no pupil being seen. T. was −2. V. = bare p. l..

The right eye was healthy. V. $= \frac{6}{6}$ and J. i.

The eye was enucleated. After hardening, an antero-posterior vertical section was made. The following condition was then seen:—Lying in the centre of the vitreous was a foreign body covered with lymph. The vitreous was detached from the retina in the greater part of its extent. Passing forwards from the foreign body to the posterior surface of the lens was a fibrous band. The lens was small and shrunken, and surrounded nearly entirely by organised inflammatory tissue. The lower part of the iris was united to this inflammatory membrane. The upper portion of the iris was bowed forwards forming the prominence above described. The retina had some creases in it. The choroid was detached from the sclerotic anteriorly. Microscopical examination shows the cystic space to be bounded anteriorly by the posterior uveal surface of the iris, and posteriorly by the anterior capsule of the lens. Some inflammatory tissue is seen uniting the pupillary margin of the iris to the lens capsule internally, and the anterior of the ciliary processes to the lens capsule externally (Fig. 5).

FIG. 5.—Section of front half of eye, showing the localised condition of bombé iris in Case 7.
(From a photograph by Mr. E. Collier Green.)

The next case is also one in which the clinical appearances of a cyst in the tissue of the iris were simulated by a very different condition of things.

CASE 8 (*Register No.* 2982).—*Dislocated Lens giving rise to the Appearances of a Cyst of the Iris.*

James M., aged 66, was admitted to Moorfields Hospital under Mr. Couper, on October 15, 1889. Seven weeks previously, while chopping wood, a piece flew up and struck his right eye. The piece that struck him had a sharp point at one end of it. He could not say if the piece entered the eye or not. His eye bled a little after it was struck. He was unconscious for two hours after the blow.

On examination, the eye showed some general haze of the cornea. At the corneal margin down and out, slight bulging of the sclerotic. The remains of a hæmorrhage at the lower part of the anterior chamber. Up and out a prominence of the iris, presenting the appearance of a cyst. The iris was of a grey colour; this prominent part was nearly black, and the fibres of the iris were plainly marked on its surface. The pupil was oval in shape, the long axis of the oval being down and in. No reflex could be obtained from the fundus. T. + 3. V. = Hand movement.

Pathological Examination of the Eye after Enucleation.—The eyeball opened by an antero-posterior horizontal section. The lens is dislocated and lying at the outer side of the globe, on the outer part of the ciliary body, with its long axis antero-posterior, so that its inner lateral margin presses forwards the iris and ciliary body almost into contact with the posterior surface of the cornea, thus causing the appearance that was thought clinically to be a cyst. The angle of the anterior chamber is markedly narrowed in its entire circumference. A membrane stretches across the pupil. The vitreous is detached posteriorly from the retina, and the latter is detached in places from the choroid. The optic disc is deeply cupped.

Microscopical examination shows the iris and ciliary body, where they are pressed upon by the lens, to be extremely atrophied. The ciliary muscle and processes are almost completely gone, and the merest trace of the uveal layer of the iris can be distinguished (Fig. 6).

Fig. 6.—Section of front half of eye in Case 8, showing the displacement of lens which gave rise to the appearance of a cyst of the iris.
(From a photograph by Mr. E. Collier Green.)

Case 9—*Case of True Cyst of the Iris with Uveal Pigment on its Anterior Surface.*

Thomas S., aged 64, was admitted into the Moorfields Hospital under Mr. Tay, on October 14, 1886. The sight of his left eye he stated had been failing two years, and of his right

six months. He had never had any pain in the eyes, nor had he noticed anything wrong with them beyond the failure of sight. He had not had any injury to his left eye.

He was a stout, plethoric, white-haired man, with a slight arcus senilis in each eye. In the right, the pupil was active; there were some opacities in the lens. V. $= \frac{3}{60}$. T. n. In the left, the pupil was active; the iris of a blue colour. Projecting from behind the lower margin of the pupil was a deep brown mobile mass, having a sharply defined curved margin with a slight notch in its centre. The lens was cataractous, nearly mature. V. = Hand reflex. Projection good. T. n. (Fig. 7).

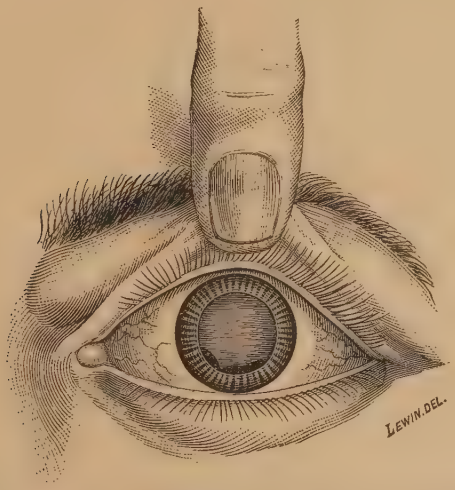


FIG. 7.—Showing cyst of iris with uveal pigment on its anterior surface. Case 9.

The dark mass was considered to be one of two things, either a melanotic growth or a cyst. To clear up the diagnosis, it was decided, in performing extraction, to make the incision and the iridectomy downwards.

This was done on October 28, an incision being made in the sclero-corneal margin. The iris, including the dark mass, was then grasped with forceps, in doing which the dark part

collapsed. The lens came away nearly completely; no sign of any new growth could be seen. The eye made a rapid and satisfactory recovery.

Examination of the piece of iris removed showed that the dark mass was evidently of a cystic nature.

This case, it will be seen, differs from all those previously mentioned, in that there was no history, nor the least sign of there having been any inflammation in the eye, and yet the cyst had uveal pigment on its anterior wall.

In order to throw light on its mode of formation, I will relate another, which, though differing in some respects, helps to explain the position and origin of the cyst in Case 9.

Case 10 (*Register No.* 2950).—*Cyst of Iris situated between its Two Layers of Uveal Pigment.*

William J., aged 10, was admitted into Moorfields Hospital under Mr. Tay, on September 4, 1889. When three years old, he had injured his right eye with a pair of scissors, and since that time had been unable to see with it. The eye gave him considerable pain at times. He could only distinguish light from darkness with it. T. was +1.

After enucleation there was found to be a slight prominence of the sclerotic beneath the external rectus muscle. There was a nebula of the cornea at the inner margin. At the upper and outer quadrant the iris was more prominent than elsewhere, being here in close contact with the posterior surface of the cornea, and of a slightly bluish tint. The remainder of the iris was of a greenish-yellow colour. There were some posterior synechiæ. At the lower part of the anterior chamber was a collection of blood. The lens was mobile, opaque, and of a yellow colour.

After hardening and making an antero-posterior vertical section, there was seen, in the upper part of the iris, a cystic space lined on both sides by uveal pigment. The lens was

composed of a dense yellowish-white capsule, with calcareous deposit in it. The central portion was of fluid consistency. Immediately behind the lens a membrane stretched across the globe. The retina was detached at the lower part from the ora serrata to the optic disc. In the centre of the outer half of the globe, corresponding to the prominence of the sclerotic noticed externally, there was a depression where all its tissues were adherent, and from this point several puckers in the retina radiated.

Microscopical examination of the anterior half of the eyeball shows :—Some collections of red blood corpuscles in the anterior chamber. An inflammatory membrane composed of fibrous tissue on the anterior surface of the iris, much thicker in some parts than in others. Close to the pupillary margin in one place it has given rise to adhesion between the posterior surface of the cornea and iris. The membrane stretches right across the pupil between the free extremities of the iris. The angle of the anterior chamber on both sides is blocked by adhesion of the root of the iris to the posterior surface of the cornea. It is still further blocked on one side by thickening of the above-mentioned inflammatory membrane. The tissue of the iris is thinned ; markedly so in some places. In the posterior part of the iris, on one side, a large cystic space is seen bounded on all sides by a layer of uveal pigment. The uvea at the tip of the iris is seen to divide as it passes backwards into two widely separated layers, which re-unite at the root of the iris. Some organised inflammatory tissue posterior to the uvea, and between it and the lens capsule, goes to thicken the posterior wall of the cyst. The ciliary processes are much atrophied and stretched. The lens is composed of a network of delicate fibres, irregular hyaline masses and granules of calcareous deposit (Fig. 8).

In the last case it will be seen there has been a separation of the two layers of uveal pigment on the posterior surface of the iris, and exudation of fluid into the space thus formed. The arrangement of the uvea on the iris I find is best studied in sections which have been bleached by first immersing them in some water with chloride of

FIG. 8.—Section of anterior half of eye in Case 10, showing a cyst situated between the two layers of uvea on the posterior surface of the iris. *c*, Cyst. *m*, Inflammatory membrane in pupil. *l*, Lens. *r*, Detached retina.

lime in it, and then in water acidulated with one or two drops of hydrochloric acid. They require to be passed backwards and forwards from these two solutions several times before the pigment is destroyed. The sections can be afterwards stained with logwood. In a typical transverse section of the iris thus prepared, the anterior layer of the uvea, which is continuous externally with the uvea of the ciliary body, and internally, at the pupillary border, joins the posterior layer, is seen to consist of a single row of flattened nucleated cells. The posterior layer, which is the most deeply pigmented portion of the whole eye, and the last to become bleached, is continuous externally with the unpigmented cells forming the pars ciliaris retinæ, and internally, as above stated, joins the anterior layer.

At the root of the iris the transition from the unpigmented quadrate cells of the pars ciliaris retinæ is seen to commence. Besides acquiring pigment, the cells become much elongated and wedge-shaped, the bases of the wedges being all directed backwards, the result being that the posterior surface of the outermost portion of the iris has a convoluted outline, the cells being arranged in little groups with depressions between them. On tracing the iris inwards, these depressions become much shallower and separated further apart. From about its centre to the pupillary border it presents a smooth surface, the cells here being of a regular columnar shape. Throughout this layer the nuclei of the cells are situated in their posterior halves. These two layers form the foremost portion of the primary optic vesicle. Detachment of the retina from its uveal layer is of common occurrence. The detachment of the two uveal layers on the posterior surface of the iris from one another may be considered as an analogous condition. Slight detachments are seen frequently in various pathological states, especially in eyes of youthful patients. It is of more frequent occurrence than detachment of the whole uvea, for the anterior layer, like the uvea in the posterior parts of the eye, has firm connections to the mesoblastic structures.

That the separation of the two layers should become so extensive as to give rise to the appearance of a tumour has not, I think, before been suggested. That such was the condition in Case 10 is proved by the pathological examination, and I think it seems the most probable explanation of the appearances seen in Case 9.

Fig. 9 shows an iris with a small cyst on its posterior surface formed by separation of its two uveal layers. It occurred in a case of sarcoma growing in the ciliary body; the pressure of this tumour on the base of the iris gave rise, not only to œdema of its stroma, which is seen to be swollen, but also to effusion of fluid between its two uveal layers, and so to the cyst.

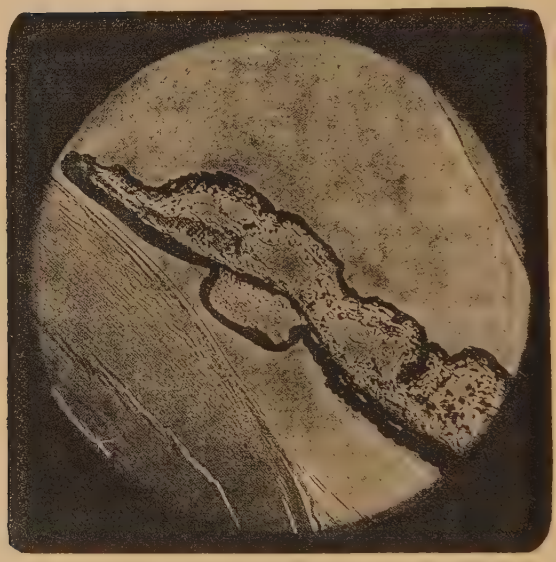


FIG. 9.—Showing a small cyst situated between the two layers of uvea on the posterior surface of iris.
(From a photograph by Mr. E. Collier Green.)

It has been suggested that some cysts of the iris have a congenital origin—that they are connected in some way with the ocular cleft. A case shown by Mr. Lang at a recent meeting of the Ophthalmological Society gives the most striking confirmation of this view. In it there was a coloboma of the iris downwards, and a cyst connected with the limb of the iris at the side of the coloboma.

Mr. Osborn* also has pointed out that occasionally a fissure of the iris is left after the cure of these cases. (This might be due to the cyst growing in the substance of the iris and expanding it, so that on its removal part of the thickness of the iris would be removed also.) He quotes, moreover, in connection with this point, Mr. Wharton Jones's case, where inflammation set in as the result of puncturing the cyst, and, as a consequence, "the matter

* St. Thomas's Hospital Reports, vol. vi, p. 69.

of the cyst worked its way outwards at the junction of the cornea and sclerotic by a narrow passage;" and continues, "Now if such a cyst was growing from some dilated or unobliterated portion of the ocular cleft, no more likely channel for the exit of its contents could be found."

A form of congenital cyst connected with the ocular cleft in the choroid in cases of microphthalmos has been described by Professor Kundrat, and was dealt with by Mr. Lang in the last number of these Reports. It is needless to repeat what has been there stated. The following annotation which appeared in the "Lancet," however, is interesting in connection with the fact that I found retinal elements in the walls of that cyst.

Dr. Monacho* recently exhibited at the Cataluña Academy and Laboratory of Medical Sciences, a little girl of 13 months, the subject of double anophthalmos. The eyelids, lacrymal apparatus, and orbits appeared to be well-formed, but there was no eye on either side, a simple cavity being seen on separating the lids. This cavity was invested by the conjunctiva, which apparently rested on some firm, fibrous basis, in which movements could be detected, as if it represented rudiments of the ocular muscles. In the thickness of both inferior eyelids a kind of bursa or cyst could be felt, that on the left side being the larger, and having a whitish coat, like the sclerotic, which could be seen through the conjunctiva posteriorly, where it was thin and transparent. This became tense during crying, and the child was observed to press it frequently with her hands, and then to smile, a phosphene or subjective sensation of light being probably thus produced.

The similarity of this case to that recorded by Mr. Lang is obvious.

Small cystic spaces between elongated bundles of Müller's fibres immediately behind the ora serrata are very common. Dr. Blessing regarded it as the normal condition between the equator and the ora serrata. In an eye

* Lancet, May 26, 1888.

recently brought to me by Mr. Lawson, which previous to removal seemed perfectly healthy, and which was enucleated on account of an adjacent sarcomatous growth, I found numerous spaces of this description in this region. These spaces are, however, only visible microscopically; cysts which look more or less like white currants adherent

Register No.	Name.	Age.	Duration and nature of affection.	External appearances.
2883	Joseph N. ..	29	Left eye injured with a fork 20 years ago; was operated on here at that time, but has been unable to tell light from dark with it since. Fresh inflammation in it during the last 2 months.	T.−. V. = no p. l. Two cicatrices, one in the centre of the cornea, and the other at its junction with the sclerotic above. Pupil blocked with opaque membrane; posterior and one anterior synechiæ.
2965	Daniel S. ..	50	Accident to his left eye 26 years ago from a gunpowder explosion; could see well with it after the accident. Sight began to fail in 1872. It has been painful for the last 14 days.	T.+2. V. = no p. l. Iris is slightly discoloured; posterior synechiæ. Pupil eccentric. Lens cataractous.
2971	Solomon D. ..	38	Said to have had congenital cataracts. Left eye operated on at Warsaw 20 years previously. A scissors operation was performed here on it in 1876, and a considerable quantity of fluid vitreous escaped. For the last 3 months it has been painful.	T.n. V. = no p. l. Episcleral vessels injected; anterior chamber deep. Coloboma upwards closed by an opaque membrane. Posterior synechiæ.

to the outer surface of a detached retina, are less frequently met with, but, according to my experience, are not very rare. Thus, during the past two years at Moorfields, I have found nine eyes containing cysts of this description.

The details of these cases I have arranged in tabular form below :—

Macroscopical appearances on section.	Microscopical appearances.		
	Retina.	Choroid.	Optic nerve.
Retina completely detached from the optic disc to the ora serrata and thrown into folds behind the lens. A large cyst projects from its outer surface in the posterior part.	The cyst is situated between the two nuclear layers. Throughout the retina, Müller's fibres are much elongated.	Atrophied.	
Retina detached from optic disc to the ora serrata. Small cyst projects from its outer surface. Angle of anterior chamber constricted. Lens shrunken.	The cystic spaces in the retina appear to commence in the inter-nuclear layer; Müller's fibres are everywhere much lengthened and hypertrophied.	Some colloid excrescences projecting from the elastic lamina.	
Retina detached in the lower half from the ora serrata to the optic disc; *in situ* above. There is a small cylindrical process of retina passing from the detached portion to the choroid, to which it is adherent. There is a small cyst a little behind this. Considerable pigmentation of retina at the upper part.	Has everywhere undergone extensive changes. It is in greater part made up of an irregular network of fibres and scattered nuclear bodies. There are numerous spaces of various sizes between the fibres. In some places these have coalesced and formed cysts. A coagulated homogeneous substance is seen in the interior of these.	Numerous colloid excrescences projecting from the elastic lamina, some of them are knobbed and project into the substance of the retina, causing considerable disturbance of the uveal pigment. There is a large excess of pigment in places, but no inflammatory infiltration.	The fibrous tissue of the nerve is much increased, and nerve fibres decreased. There are numerous very small round spaces along the track of the nerve fibres on the inner surface of the lamina cribrosa.

Register No.	Name.	Age.	Duration and nature of affection.	External appearances.
2972	Mary Ann H.	41	Left eye was struck with a fist 14 years ago, and went blind at once. It has been painful during the last 5 months.	T.−1. V. = no p. l. General haze of cornea and an irregular brownish opacity at the lower and inner part. Pupil widely dilated.
2977	Joseph D. ..	30	Right eye "went blind from inflammation 7 years ago;" no injury then. A week ago he knocked it with his finger.	T.+. V. = no p. l. General haze of cornea. Aqueous turbid, a hæmorrhage on surface of iris. Lens opaque.
3080	Josias E. ..	32	Left eye struck by a piece of gun-cap 13 years ago, after which sight became dim. Five years ago "took cold" in the the eye, and the sight went completely. During the last month it has been painful.	T. + 1. V. = no p. l. A yellow spot in the centre of the lower half of the cornea. No iris can be seen; the whole cornea gives a dark reflex.

Macroscopical appearances on section.	Microscopical appearances.		
	Retina.	Choroid.	Optic nerve.
Umbrella detachment of retina. Two cystic protrusions from the posterior part about the size of currants; they are filled with a coagulated gelatinous substance similar to that found between the choroid and retina.			
Lens is white and of stony hardness throughout. There is some calcareous deposit in the retina, which is detached from ora serrata to optic disc. There are seven small cystic protrusions from its outer surface, one of them much pigmented; and in the choroid beneath it is an atrophic patch, with deep pigmented margin.	Extensive degenerative changes of the nerve elements, and considerable increase of the fibrous tissue; numerous spaces of various sizes throughout. The larger cystic spaces contained a homogeneous substance.	Much atrophied; a few colloid nodules project from the elastic lamina.	Considerable increase in the number of cells in optic nerve adjoining sclerotic. Also increase in the amount of fibrous tissue.
Anterior chamber deep, and full of blood clots. Anterior synechiæ. Lens absent. Vitreous shrunken. Retina detached from ora serrata to optic disc; there is a large cyst in the middle of its substance at the lower parts, not projecting more to the inner than to the outer side of it. Blood clots between retina and choroid.	Tissue much disorganised, composed of a network of fibres and nuclear bodies. In the interior of some cysts a delicate network can be seen.	Much atrophied.	Deeply cupped and excavated; nerve fibres very much atrophied.

Register No.	Name.	Age.	Duration and nature of affection.	External appearances.
3081	Ellen G. ..	56	Right eye went blind suddenly 6 years ago, without any pain or inflammation. A blow on the same eye 4 months ago.	T.n. V. = no p. l. Cornea has a central circular patch, discoloured with blood. Blood clots in anterior chamber.
3083	Alfred H. ..	46	Right eye injured 4 or 5 years ago; blind since then. Painful during the last few weeks.	T. + 2. V. = no p. l. Nebulæ of cornea; anterior chamber full of dark blood.
3105	James T. ..	27	Right eye lost by inflammation in early childhood; said to have been burnt with caustic.	T. − 2. V. = no p. l. Cornea flattened, vascular, and opaque.

The condition of the retina found in the above cases corresponds to what has been described by Dr. Iwanoff,* under the name of "œdema of the retina," which condition always precedes the formation of cysts. He suggests it may be due to granular or calcareous degeneration of the capillary blood vessels.

In all my cases, and also in those recorded by Mr.

* Archiv f. Ophth., 1869, vol. ii, p. 88.

Macroscopical appearances on section.	Microscopical appearances.		
	Retina.	Choroid.	Optic nerve.
Retina completely detached from ora serrata to optic disc. In the outer half two transparent cysts project from its outer surface. Lens opaque and calcareous.	Nuclear layers in places are distinctly made out. Other layers are indistinguishable. Numerous spaces of various sizes left between the trabeculæ of the network of fibrous tissue of which it is chiefly composed.		
Retina completely detached from ora serrata to optic disc. At the posterior part near the optic disc are two small, cystic protrusions from its outer surface. Cyclitic membrane behind lens. Lens displaced backwards by hæmorrhage into anterior chamber. Iritic angle much narrowed.	Great increase in the fibrous tissue elements. Ganglion cells, and rods and cones almost entirely gone. The external walls of the cysts in some places exceedingly thin. Numerous small spaces throughout of various sizes.	Atrophied.	Deeply cupped. Large increase in the number of nucleated cells. Nerve fibres diminished.
Retina detached from ora serrata to optic disc. Projecting from its outer surface are several cysts of various size, one very large. There is some pigmentation on it. Lens shrunken with a calcareous patch in it.	..	..	Considerable increase in the fibrous tissue of the nerve, and in the number of nucleated cells.

Nettleship,* and in three by Mr. Lawford,† the eyes had been quite blind for some considerable time previous to the enucleation. In all these cases, too, the retina was in part detached, and in by far the majority completely so. When we reflect on the distribution of the vessels in the retina; how they pass in and out at the optic papilla; how

* Ophth. Hosp. Rep., vol. viii, p. 343.
† Ophth. Hosp. Rep., vol. ix, p. 208.

they are distributed only to the retina itself, and form no anastomoses with the choroidal vessels; how the arteries have their usual coats, while the veins consist of a single epithelial layer, outside which is a lymphatic sheath, the suggestion at once occurs that an œdematous condition of the retina would be most likely caused by some changes in the optic nerve itself; which, while being insufficient to arrest the blood-flow through the thick walled arteries, yet would cause considerable venous congestion by pressure on the thin-walled veins, and arrest in the lymphatic streams in the sheaths outside them.

I have shown in the table that a change which would be likely to produce this condition of things was present in the nerves of every case where I made a microscopical examination, and, in that none of the cases had any perception of light, I think it may be taken that some atrophic changes had occurred in them all.

If an atrophic condition of the optic nerve was sufficient to produce cysts of the retina in these cases, should not atrophies arising in other ways have a similar result? I think there is a second determining cause, and that is that the retina shall be detached. When it is supported on one side by the choroid, and on the other by a consistent vitreous, cysts do not form. When, however, the tissues are abnormally lax, with only subretinal serous fluid externally, and a fluid or shrunken vitreous internally, no obstacle is offered to the wide expansion of the lymph spaces, and effusion of fluid into the tissues around them. When this œdema has persisted for some time, a large increase in the connective tissue elements takes place, similar to what occurs in other parts of the body where the lymph streams are obstructed. Thus we find the large hypertrophied bundles of Müller's fibres, and an increase in the areolar tissue network of the retina. The reason why the outer layers of the retina yield and give rise to the cysts may be, as suggested by Mr. Lawford, that it is the direction of least resistance; or it may be due to the

arrangement of the lymphatics. In that the blood vessels are confined in their distribution to the inner layers of the retina, not penetrating the outer molecular layer, it is natural to suppose that the chief lymph supply is in the outer layers, and consequently, in the œdema, larger spaces would be formed in them.

Mr. Nettleship says :—"In two specimens which I have examined the relation of the 'œdematous' or 'cystic' part of the retina to the outer tissues of the eye was such as to suggest that some inflammatory affection of the sclerotic and choroid, followed by bulging outwards of the tissues, had been instrumental in causing the outgrowth of Müller's fibres, which constitutes the most marked feature of the retinal changes."

In a third case he summarises the processes which probably occurred as follows:—"1st, adhesion of the outer surface of the retina to a small patch of choroid by inflammatory effusion; 2nd, detachment and more or less shrinking of the retina surrounding the adherent patch; 3rd, a separation of the inner and outer layers of the adherent part of the retina, with over-growth of Müller's fibres; 4th, owing to the continued retraction of the surrounding detached retina, the part which, by its outer layers, remained adherent to the choroid, became at last separated from that structure, and formed the outer wall of the cyst-like patch on the retina."

Given an œdematous condition of retina, such adhesions and such shrinkings would doubtless tend to stretch and break down thin partitions between adjoining spaces, and thus to be the determining cause as to the site at which the cysts appeared. Cases numbered 2971 and 2977 support this view. In the others, however, there is no evidence of such an explanation being applicable.

The following case is a very exceptional one; in it a cyst occurred in the retina (possibly congenital in origin), the eye being otherwise perfectly healthy. The patient was a private one of Mr. Tweedy's; he brought me the

eye to examine microscopically and has kindly given me his notes of the case to publish.

Cyst of the Retina.

Miss H., æt. 7 years, was first seen May 4th, 1889. A few months previously the parents had noticed a slight divergent squint of the right eye, and this had increased.

On examination, the right eye could only distinguish hand-movements in the lower part of the visual field. The cornea was clear and bright; the anterior chamber rather deeper than the left; the pupils of the eyes were equal. The media were clear, but from the upper and lower borders of the optic disc was a broad white band, like opaque nerve fibres, which extended circularly around the macular region. This area thus enclosed formed a prominence at the posterior pole of the eye, having a circumference of about 5 discs breadth.

The temporal side of the patch was jagged, woolly, and flocculent looking. The summit of the prominence could be seen with about +9D. and the disc with +2D.

On the surface of this area were many fine blood clots and a delicate network of new vessels; the normal retinal vessels were varicose and dilated. Some of the central vessels ran along the broad white bands, which extended from the upper and lower margins of the disc.

The case was watched for about a month, but did not undergo any material change in appearance. As a new growth was believed to exist, the eye was excised on June 24th with the concurrence of Mr. Couper, who saw the case in consultation.

Pathological Examination.—The eyeball was opened by an antero-posterior section. The anterior portions of the globe appeared quite normal. In the retina, on the outer side of the optic nerve, was found a cystic space, measuring 6 mm. laterally. Its anterior wall was thicker than the posterior; around the upper and lower margins of the cyst white lines were seen passing.

Microscopical Appearances.—The cyst is formed by a separation of the outer and inner nuclear layers, that is in the outer molecular layer. On tracing the retina from the margin of the optic disc, as it proceeds outwards the layers are not

distinct as on the inner side. The two nuclear layers and the nerve cell layer can be distinguished, but they are irregular and not sharply defined. At the margin of the cyst the two nuclear layers diverge, the inner one can be traced throughout the inner walls of the cyst, but the outer one soon becomes indistinguishable in the outer wall.

In the inner wall of the cyst numerous circular spaces are seen, which are bounded by dark, well-defined margins. In some parts, especially near the anterior extremity of the cyst, these circular spaces have united and formed larger irregular spaces of various sizes. In others, three or four of these circular spaces are in contact, separated only from one another by their dark margins. In the part of the retina beyond the cyst several similar round spaces are seen in its outer layers. In the inner wall of the cyst the blood vessels are numerous; their walls are thick and the lymphatic sheaths around them dilated. The fibres of the optic nerve lose their medullary sheaths before piercing the lamina cribrosa. The choroid beneath the cyst is healthy (Fig. 10).

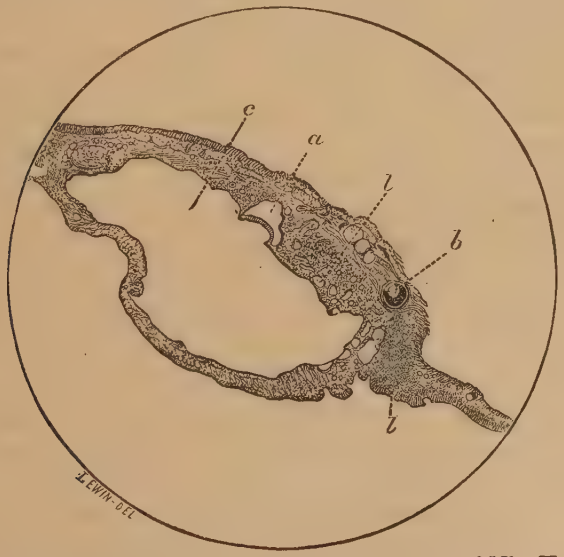


FIG. 10.—Section of cyst of the retina in the case of Miss H. *l*, Dilated lymphatics. *a*, Space formed evidently by union of dilated lymphatics. *c*, Cyst. *b*, Blood-vessels.

In considering the cause of the cyst in this case, the first point, I think, is to determine the nature of the white lines which were seen encircling it both ophthalmoscopically and after excision. They were certainly not opaque nerve fibres, for the fibres of the optic nerve, as I have stated above, can be distinctly seen to lose their medullary sheaths at the lamina cribrosa. The only things that can be seen microscopically which will account for them are the small regularly circular spaces with well defined walls, the distribution of which in the parts of the retina around the cyst and in its anterior wall corresponds to that of the bands described by Mr. Tweedy. These spaces are certainly not blood vessels in section, in none of them can any red blood corpuscles be seen. They must, I think, be enlarged lymph vessels cut across. It is evident that the large cyst has been formed by the junction of numbers of these small spaces, for all stages can be found from where two or three of them are in close contact, being separated only by the dark lines which surround them, up to where an irregularly shaped cavity has been formed.

I think, then, this case may be considered to have primarily been a lymphatic nævus of the retina, and, as occasionally occurs in such structures in other parts, a cyst has formed in its centre, the result of breaking down of partitions between several of the vessels composing it. Support is given to this view by a case shown at the Ophthalmological Society by Mr. Gunn, on July 4th, 1890. The patient was a little girl with a congenitally microphthalmic eye, in the conjunctiva of which the lymphatics were very much enlarged, tortuous, and very prominent. Ophthalmoscopically a raised pale patch could be seen in the fundus. Here the fact of there being dilated lymphatics in the conjunctiva suggested strongly that the patch in the retina might be due to a similar dilatation of those situated in it.

I only know of one reported case in which a tumour of

the retina could be seen with the ophthalmoscope, and which afterwards, on pathological examination, proved to be a cyst. That is one of M. Panas.* An account of the second eye of this same patient has recently been given by Dr. Darier.† In it a tumour, presumably retinal and cystic as in the first eye, had been watched to gradually increase in size, and involve the whole fundus.

* Anatomie Pathologique de l'Œil.
† Archives d'Opht., 1890, p. 203.

THE DIVISION OF ANTERIOR SYNECHIÆ.—A FURTHER CONTRIBUTION.

By William Lang.

Surgeon to the Hospital and Ophthalmic Surgeon to the Middlesex Hospital.

In the last number of our Reports I described a method of dividing anterior synechiæ by means of a pair of knives, one sharp and the other blunt pointed. At that time I had used them in but a small number of cases, but the success I obtained induced me to extend their use beyond the limit I had then laid down as their sphere of utility. I now record a fresh series of cases, with some remarks which I hope will help to facilitate the execution of the operation.

I have to thank my friend and colleague, Mr. Waren Tay, for his kindness in giving me all the cases of anterior synechiæ occurring in his clinic; I have thus been able to operate on about thirty cases. The cases divide themselves into four groups: first, adhesion of iris or capsule to wound after extraction. Of these I have had seven cases, and in all the division was performed nearly as soon as the anterior chamber was re-formed; in one only was the iris prolapsed, and, there being a good interval between the angle of the anterior chamber and the corneal section, the iris was drawn into the anterior chamber by the blunt knife, but, the aqueous escaping, it became adherent to the inner lips of the wound, from whence it was readily detached a few days later. In most of the cases the iris was adherent by its anterior surface, where it lay in contact with the corneal wound, and in some it would have been almost impossible to have divided it in any other way. These were all linear extractions for soft cataract. The entangled capsules by their elasticity required several attempts before the division was completed—as many as four in one case. Where the lens is absent more boldness of manipulation can theoretically be

attempted, but in practice excessive movements of the knife allow the aqueous to escape prematurely. The employment of eserine both before and after the operation is extremely useful in some cases in drawing apart the divided surfaces. In other cases, where the adhesion is central, atropine better fulfils the same purpose.

The second group consists of traumatic prolapses, which have not been seen in an early state, and where a broad width of iris is clamped in the scar. Of these I have had two cases, and, as they occurred in young children with small, soft, yielding eyes, I found it impossible to divide them. The iris in these cases stretches so freely, and the cornea collapses so much, that it is impossible to get sufficient space in the limited anterior chamber to cut it. In an adult I succeeded in dividing a similar entanglement by making my opening opposite the scar, and cutting the iris at right angles to the direction of the wound; this was possible owing to the greater depth of the anterior chamber in the adult eye.

The third and most numerous class of case has been small adhesions, either due to perforating wounds or ulcers; these have also given the least trouble to divide, and, except when occurring close to the periphery, have never required dividing more than once.

The last and most important group is that of the large adherent leucomata, occurring either in infants or in adults, and these are also the least satisfactory cases, because most of them come under observation when secondary glaucoma is well established; if they were seen and treated as soon as the anterior chamber was re-established many of them could be cured, even when the leucoma extended up to the periphery of the cornea and would thereby, apparently, prevent the blunt knife passing around the adhesion. The angle of the anterior chamber, however, is formed by the iris and the anterior portion of the sclerotic, which under no circumstance perishes from ordinary ulceration; consequently there is always a fair-

sized area where the iris is not adherent to the scar, and which, therefore, allows the knife to pass around the adhesion. If these cases were seen before the iris had formed such intimate connection with the scar as to preclude division, many of these eyes might be saved from secondary glaucoma and blindness. Two such eyes came under observation: the first was due to an hypopyon ulcer, which occurred in an only eye; increased tension occurred at once after healing; a liberal iridectomy was performed, and was repeated on two other occasions; still the tension kept up, and the field continued contracting, and there was no more iris to remove, except that adherent to the scar. It was about the time I devised the blunt knife that the patient came in for a sclerotomy, and before doing it I determined to divide the adhesion; this I found quite easy of execution, but being devoid of support the flap of iris fell back and re-adhered, and I had to perform the sclerotomy, which fortunately was successful in reducing the tension. In the second case, the tension was +2, and the vision only bare perception of light, before I divided the adhesion. The division was followed by extensive hyphæma, which again glued the iris to the cornea.

If in every case of adherent leucoma, where there is no corneal staphyloma, an attempt to divide the adhesion were made, I am convinced that many eyes would be saved that now perish through secondary glaucoma. This termination, so common in large adhesions, had occurred in one of the cases of entangled capsule after extraction, and also in two of the small anterior synechiæ. The importance, therefore, of relieving every anterior synechia can not be too strongly urged, especially as it can be done without any risk of wounding the lens, and with every chance of success, even if the operation has to be repeated more than once; for if once the adhesion has been divided, and is followed by re-adhesion, careful selection of seat and obliquity of puncture, and use of either atropine or eserine, will lead to success.

ON THE DEVELOPMENT AND ABNORMALITIES OF THE ZONULE OF ZINN.

By E. Treacher Collins,
Curator of the Museum.

Very little is known as to the development of the suspensory ligament of the lens or zonule of Zinn. Balfour* in his work on Comparative Embryology thus refers to it:—"The development of the zonula of Zinn in mammalia, which ought to throw some light on the nature of the vitreous humour, has not been fully investigated. According to Lieberkühn, this structure appears in half-grown embryos of the sheep and calf. He says, 'At the point where the ciliary processes and the ciliary part of the retina are entirely removed, one sees in the meridian bundles of fine fibres, which correspond to the valleys between the ciliary processes and fill them; also between these bundles there extend, as a thin layer, similar finely striated masses, and these would have been on the top of the ciliary processes.' He further states that these fibres may be traced to the anterior and posterior limb of the lens capsule, and that amongst them are numerous cells. Kölliker confirms Lieberkühn's statements. There can be little doubt that the fibres of the zonule are of the nature of connective tissue; they are stated to be elastic. By Löwe they are believed to be developed out of the substance of the vitreous humour, but this does not appear to me to follow from the observations hitherto made. It seems quite possible that they arise from mesoblast cells which have grown into the cavity of the vitreous humour; solely in connection with their production."

In the tenth edition of Quain's Anatomy,† we find:—"The development of the hyaloid membrane has not been

* Vol. ii, p. 495.

† Vol. i, p. 87.

fully traced out, and the same may be said with regard to the zonule of Zinn. They are probably both formed by part of the same mesoblast as forms the vitreous humour (Lieberkühn, Angelucci)."

All this leaves the matter very indefinite. My attention was first directed to it by the examination of an eyeball which had been enucleated from an infant aged three months, under the supposition that it contained a new growth. Pathological examination, however, revealed that the opaque mass behind the lens which had been taken for the growth was really a collection of cells and fibres into which a persistent hyaloid artery, still patent and carrying blood, passed and broke up. The chief interest of the specimen, however, centred in the fact that it exhibited the fibres of the suspensory ligament in all stages of their development; several of these are shown in Figs. 1 and 2. The fibres of the lens, instead of developing in their normal way, filling and rendering tense the capsule in which they were contained, had undergone retrogressive changes, and left the capsule lax and wrinkled. Whether this was the result of the persistence of the hyaloid artery, or whether it had persisted as the result of changes in the lens, I am unable to determine. Anyhow, as the result of the lax condition of the capsule, the fibres of the suspensory ligament do not appear to have become stretched to their usual extent, and hence we have exhibited all stages of delayed development in them. The full details of this case are given at the end of this paper.

I will now sketch what I find, from the examination of this eye, and from the examination of sections of several human fœtal eyes, to be the course of events in the development of the zonule of Zinn, first briefly stating the steps preparatory to it.

The process of cuticular epiblast, which dips in to form the lens, indents the primary optic vesicle, and at first lies in contact with what becomes the inner layer of the

secondary optic vesicle. Gradually the ingrowing process gets cut off from the surface epiblast, forming thus the primitive lens, which next becomes separated from the inner layer of the secondary optic vesicle at the posterior part, by the formation of the vitreous. It remains, however, for a long time in contact with it at its sides, that is, at that part in which subsequently the ciliary body becomes developed. The lens becomes encircled by what is termed its fibro-vascular sheath, derived in part from the central artery of the vitreous, and in part from vessels growing in between the lens and the cornea. The portion of the inner layer of the secondary optic vesicle still in contact with the lens, that is, the pars ciliaris retinæ, acquires adhesions to this sheath. Then, as the eyeball enlarges, it does so at a greater rate than the lens, so that a portion of the ciliary body which was in contact with the lens grows away from it, and the adhesions which have formed between them become stretched, and the cells forming them much elongated, until only fibres with nuclei lying on them can be distinguished, and ultimately the nuclei also go, leaving only the delicate fibres of the suspensory ligament as we see them in the adult eye.

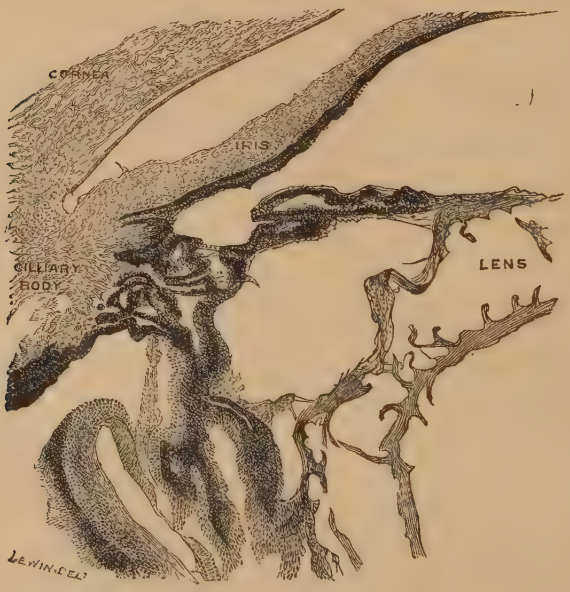
The lens is at first of a globular shape, measuring almost as much antero-posteriorly as laterally. From the drag exerted on its capsule at its peripheral parts, by the growing away from it of the ciliary body, which has acquired adhesions to it, it tends to increase in size laterally more than antero-posteriorly, and hence assumes the lenticular form of the adult lens.

As was first pointed out by Von Ammon, and as has been recently commented on by Mr. Gunn,* in connection with the phenomenon of watered silk retina, rucks are found in the retina of all human fœtal eyes. It would appear that the inner layer of the secondary optic vesicle grows at a greater rate than the outer, and so gets

* Ophth. Hosp. Rep., vol. xi, p. 350.

thrown into the folds, which, as the eyeball afterwards expands, get flattened out. The most pronounced of these folds are, I find, at the ora serrata, which at one time is actually in contact with the posterior and lateral part of the lens capsule. It then acquires adhesions to this latter, and, on the further development of the eye, when the retina has become expanded and flattened out by the enlargement of the globe and the growth of the vitreous, these adhesions become much stretched and elongated, forming thus the hindermost attachment of the suspensory ligament. Figs. 1 and 2 show some of the

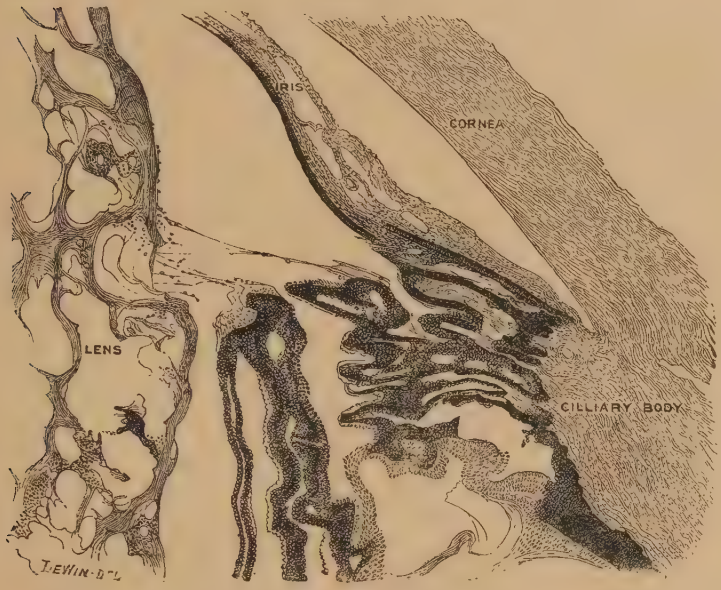
Fig. 1.



stages in the development of a fibre of the suspensory ligament. In Fig. 1 an adhesion, passing from a ciliary process to the capsule of the lens, composed entirely of spindle-shaped cells is represented. In Fig. 2 several fibres are seen exactly like those found in the normal adult eye, with the exception that every here and there

they have nuclei on them, clearly indicating their cellular origin.

Fig. 2.



I have been unable to determine definitely whether the cells from which these fibres develop are derived from the fibro-vascular sheath of the lens, or from the cells of the inner layer of the secondary optic vesicle which form the pars ciliaris retinæ, or in part from one and in part from the other. The fact that they belong to the connective tissue class would lead one to expect, that they are more likely mesoblastic in origin, and therefore derived from the fibro-vascular sheath, than epiblastic, and derived from the pars ciliaris retinæ.

In a series of human fœtal eyes which I have of various ages, from 4 months up to the 9th month, the gradual separation of the ciliary processes and of the fold of the retina at the ora serrata from the sides of the lens with which at first they are in contact, is well shown.

The following table shows the gradual relative altera-

tion in size of the diameters of the eyeball, and of the lens, throughout fœtal life. Though the number of eyes I have had the opportunity of measuring is small, I think the results are sufficiently accurate for my purpose. There is a possible source of error in my figures, from the fact that all the measurements were made after the eyes had been hardened in Müller's fluid. On account of there being necessarily some delay in my obtaining the eyes after removal, this was the only course open to me. In every case an antero-posterior vertical section was made of the eyeball, and the lens measured *in situ*:—

Age.	No. of eyes examined.	Diameters of eyeball.			Diameters of lens.	
		Antero-posterior.	Lateral.	Vertical.	Antero-posterior.	Transverse.
4th month	3	8·1 mm.	7·8 mm.	7·5 mm.	2·8 mm.	3·3 mm.
5th month	1	11·75 mm.	11·5 mm.	10·5 mm.	3·5 mm.	4 mm.
6th month	4	12·5 mm.	12 mm.	11·1 mm.	3·8 mm.	4·5 mm.
7th month	8	14·3 mm.	13·2 mm.	12·6 mm.	4 mm.	5 mm.
9th month	3	16·75 mm.	16 mm.	15·3 mm.	4·3 mm.	5·75 mm.
Adult....	Merkel	24·3 mm.	23·6 mm.	23·4 mm.	3·7 mm.	9 mm.

The points which this table shows, bearing upon my subject, are:—First, that the diameters of the globe at the 9th month are just double what they are at the 4th month, and in the adult treble the size; that the transverse diameter of the lens is likewise double in the 9th month, and treble in the adult what it was at the 4th month. So supposing, as is the case, that the ciliary body touches the sides of the lens at the 4th month—in that the eyeball is much larger than the lens to begin with, and both increase to double and treble their size—then, unless the thickness of the coats of the eyeball also become double or treble what they were—which they do not—there must be a gradual

growing away of the ciliary body from the sides of the lens.

Secondly, that the transverse diameter of the lens, which at the 4th month is only a little more than the antero-posterior diameter, in the adult lens is nearly three times as much. This globular form of the fœtal lens has been pointed out by Otto Becker and others.

Thirdly, it would appear that the lens in adult life measures somewhat less antero-posteriorly than what it does in fœtal life. I do not think the number of eyes I have examined are sufficient to make this certain, still the explanation I have given of the development of the suspensory ligament renders it likely. It would be only natural that, when the tension caused by the stretching of the fibres of the ligament due to the enlargement of the globe became felt, some flattening from before backwards of the soft lens matter and bowing of its fibres should occur.

The above description of the way in which the zonule of Zinn develops not only throws light on some of the congenital abnormalities met with in connection with the lens, but also receives considerable support from its mode of explaining them.

Taking first the condition known as *coloboma lentis*, an excellent *résumé* of the literature of which malformation, together with two new cases, has been published by Dr. Heyl,* I cannot do better than quote the passage in which he sums up:—"From the preceding, it may then be seen that coloboma of the lens is a condition which presents at the place of defect an edge, not rounded as in the normal condition, but either straight in the horizontal direction or incurved; that the amount of deficiency varies from a slight indentation to about one-quarter of the lens substance, the centre of the lens, its poles, and the lens substance in the immediate vicinity being uninvolved;

* Trans. of 5th Internat. Ophth. Congress, p. 16.

that the lens sometimes, in addition to the defect, is imperfectly developed in all its meridians; that the deficiency is always in the inferior half, and, almost without exception, entirely so; and, finally, that coloboma of the other ocular structures frequently co-exists, but very frequently no trace of it can be found."

Now, supposing the pars ciliaris retinæ failed to acquire adhesions to the lens capsule in one part of its circumference, it follows that the suspensory ligament would be absent in that position; and that as the eyeball enlarged, that portion of the capsule to which no suspensory ligament was attached would not be held taut, and made to expand, like the remainder. Consequently there would be a depression in the lens in that situation. The amount and shape of the deficiency would depend on the extent of the defect in the suspensory ligament. There would not, of course, be any alteration in the nucleus or poles of the lens, for these are formed before the influence of the suspensory ligament comes into play. The most likely cause for the non-adhesion, and so for the defect in the suspensory ligament, would be the absence of the ciliary body or pars ciliaris retinæ, in fact, a coloboma of the ciliary body. And Dr. Heyl says this condition does frequently co-exist with a defect in the lens, the defect being at the situation of the fœtal cleft.

Mr. Gunn,* regarding the condition of coloboma lentis from the clinical side, has arrived at a similar conclusion as to its mode of formation; thus, he says:—"The notch in the lower border of the lens may be accounted for by the imperfect development of the ciliary processes and suspensory ligament, so that the soft lens is not here drawn outwards into its normal comparatively sharp curve at its equator."

The same observer† has recently pictured and described a case of a congenitally misplaced and notched

* Ophthalmic Review, vol. viii, p. 234.

† Trans. Ophth. Soc., vol. ix, p. 166.

lens, in which a distinct gap in the suspensory ligament was visible, corresponding to the notch.

Ectopia lentis or congenital displacement of the lens has been attributed by Becker to irregular development of the suspensory ligament. And I think the explanation I have given of the mode of formation of the latter helps us to understand how this comes about.

The literature of the subject has been carefully worked up by Dr. D'Œnch,* and he ends his article with the following conclusions:—

"1. Ectopia of the lens is a malformation, the causes of which, thus far, remain unknown.

"2. It always affects both eyes, generally in a symmetrical manner.

"3. The direction of the displacement is almost always either upward, upward and inward, or upward and outward.

"4. The lenses are generally transparent; sometimes their size is below the mean.

"5. The suspensory ligament is sometimes found, sometimes not.

"6. In about one-fourth of all cases there is myopia.

"7. The position of the lenses may remain unchanged throughout life, but spontaneous dislocation may also result.

"8. Heredity has been proven."

Supposing the adhesion, which takes place between the capsule of the lens and pars ciliaris retinæ to form the fibres of the suspensory ligament, be absent over a large area, then on the expansion of the globe there would be no counteracting force on one side to hold the lens in position, and it would be drawn towards that side on which the adhesions had formed. The determining cause as to whether a coloboma of the lens be formed, or an ectopia, would depend on the extent of the deficiency in the suspensory ligament. In some cases, as would be

* Archives of Ophthalmology, vol. x, p. 89.

expected, both are present. When the deficiency is very great indeed the lens would be mobile, and might become dislocated.

Abnormal density or frailty of the adhesions in part of the circumference would also be likely causes of displacement of the lens, and would account for those cases in which some of the fibres of the suspensory ligament can be seen passing (in a case of displacement upwards), from the lower margin of the lens to the ciliary body.

Delay in the closure of the fœtal cleft, though it did not lead to a permanent coloboma of the ciliary body, could yet lead to ectopia of the lens; for the eye might have expanded to such an extent, that the lens would have been drawn away from the lower portion of the globe, before the ciliary process had sufficiently developed to have acquired adhesions to its capsule.

Mr. Nettleship,* in his text-book on diseases of the eye, says :—"Congenital dislocation of the lens is often accompanied by other defects of development, such as coloboma."

It is noteworthy that the lens is almost invariably displaced upwards, either directly or with some inclination inwards or outwards, that is to say, it is almost always displaced in the opposite direction to the fœtal cleft, which we know is generally downwards or downwards with either a slight inclination inwards or outwards.

The second case, of which I give the details at the end of this paper, resembles in several points the first. Both were diagnosed as cases of glioma of the retina, and the eyeball accordingly enucleated. In both the central hyaloid artery was persistent and patent, and in both it terminated anteriorly in a mass of cells and fibres at the posterior surface of the lens. The lens, however, in the two cases was different, for in the second case it was well formed and the capsule tense, though more globular than usual, and with some irregularity of its cells and fibres at the

* Diseases of the Eye, 5th Ed., p. 181.

posterior part. The relation of the ciliary processes in the second case was also peculiar, for on one side of the sections they all passed behind the lens, being adherent to the mass on its posterior surface; while on the opposite side they were arranged in their usual way, some in front and some behind. The lens thus appeared displaced forwards, somewhat on one side. Nassaux* has figured and described a case very similar to mine, in which all the ciliary processes were behind the lens, adherent to the mass in which the hyaloid artery terminated.

Grolman† records a case of microphthalmos with a congenital vascular cataract and persistent hyaloid artery, in which he pictures the ciliary processes as having adhesions to the fibro-vascular sheath of the lens.

In a microphthalmic eye examined by Hess‡ there was a persistent hyaloid artery, dividing into branches in a membrane behind the lens, which latter was small and displaced upwards, there being a coloboma of the iris downwards. The iris and ciliary processes above were adherent to the anterior face of the lens; below they turned backwards along the lower surface of a bundle of fibres, which was prolonged forwards through the coloboma from the membrane behind the lens.

It would seem that when the central artery of the vitreous remains persistent and patent, the fibro-vascular sheath behind the lens also persists and becomes much thickened, and that the relation of the ciliary processes to the lens in some of these cases becomes altered, the latter being displaced forwards in front of them, between them and the iris. As the result of this they form adhesions entirely to the posterior part of the fibro-vascular sheath, and not any to its sides or anterior part. Consequently, as the globe expands, no lateral traction is exerted on the lens capsule, and the cells in the region of

* Archives d'Opht., T. 3, p. 502.
† Archiv für Ophth., B. xxxv, Ab. ii, p. 187.
‡ Archiv für Ophth., B. xxxiv, Ab. iii, p. 148.

the nucleated zone, instead of flattening out into fibres at the sides of the lens, spread round its posterior capsule, line it, and afterwards swell up into cells resembling epithelial cells of a large type. These are represented diagrammatically, and, of course, out of proportion to the rest of the structures, in Fig. 4. The lens thus comes to have a shape more globular than normal.

Case 1.—Edgar D., aged 3 months, was brought to Mr. Couper, at the Moorfields Hospital, on March 7th, 1890, by his mother, who stated that she had noticed from his birth that his left eye was different to his right. At first, she said, there were two small white specks on it; which gradually became larger and covered the sight. There had not been any discharge from the eyes, and they had not been inflamed. It was her sixth child. Two of the others had died of convulsions while teething. There was no history of any eye affections or tumours in either the mother's or father's family.

On examination of the left eye the cornea was seen to be clear. The iris was in close contact with its posterior surface, there being no anterior chamber. The pupil was blocked by a greyish opacity. The right eye was apparently normal.

A new growth in the left eye was suspected, and it was enucleated on March 11th, 1890.

Pathological Examination.—The tension of the eye was full. The antero-posterior diameter measured 15·5 mm. and the vertical 14 mm. The cornea, which was slightly hazy, measured 9 mm. across. On section of the eyeball, the iris was found in contact with the cornea throughout its whole extent. The lens was in contact with the posterior surface of the iris; it presented a very irregular appearance. It was shrunken and irregularly mottled, and on its posterior surface was an opaque white mass. The ciliary processes on each side passed vertically inwards, and appeared long and narrow. The vitreous was of good consistency. Passing through its centre from the optic disc to the posterior surface of the lens was a delicate grey band, the unobliterated hyaloid artery. The retina had several little puckers in it. Anteriorly in the entire circumference there was a large fold, which touched the posterior surface of the lens at its periphery.

Microscopical Examination.—The iris has attached to its anterior surface at its pupillary margin on one side a process composed of cells and a loose fibrous network, the other extremity of which floats free in the anterior chamber in the pupil. It is evidently a remnant of the pupillary membrane. The two layers of pigment on the posterior surface of the iris have become somewhat separated towards the pupillary margin, and on one side there seems to have been some slight adhesion of the iris to the anterior capsule of the lens.

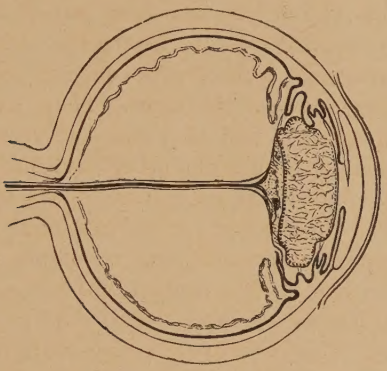


FIG. 3.—Represents a diagrammatic section of the eyeball in Case 1.

The lens is composed in greater part of a network of hyaline substance with large irregular spaces in it. Its capsule is wrinkled, and has cells lining it throughout its entire circumference. In the anterior part of the lens in some of the sections there is a mass of nucleated cells. Behind the posterior capsule of the lens, and intimately in contact with it, is a collection of fibres and cells, some round and some spindle-shaped. This collection is thickest in the centre, and tapers off on each side, where some of the ciliary processes are adherent to it. The hyaloid artery passes into it, and breaks up there into branches.

The ciliary processes are narrow; in some places they lie in contact with the lens capsule. The foremost ones have, stretching between them and the lens capsule, fibres like the fibres of the suspensory ligament, with every here and there nuclei lying on them. (See Figs. 1 and 2.)

These fibres as they approach their insertion into the ciliary processes become thicker, and in some places composed of several layers of elongated cells, which gradually become merged into the layer of unpigmented cells covering the ciliary processes. The hindermost ciliary processes have passing out from them processes composed of spindle-shaped cells, which are connected with the mass of cells behind the posterior capsule.

In some cases a direct adhesion between the lens capsule and a ciliary process is seen by means of elongated cells.

The portion of retina between the ora serrata and the hindermost ciliary process is exceedingly short. Fibres with nuclei on them pass from it to the mass of cells at the back of the lens. At the ora serrata the retina is folded inwards. The layers of the retina present their normal appearance. The choroid has fewer vessels and more cells in it than usual; scarcely any of these are pigmented. The central artery of the vitreous can be traced as a continuation of the central artery of the retina, from the very centre of the optic disc to the posterior surface of the lens, where it divides and is surrounded by the mass of cells as above mentioned. Red blood corpuscles are seen in the artery. While in the vitreous it lies in a canal lined by cells.

Case 2.—Rosa S., aged 4½ months, was admitted as an in-patient, under Mr. Hulke, at the Moorfields Hospital, on September 30th, 1887. Her mother stated that the child was born with the lids of her right eye discoloured, like a "black eye." This discoloration lasted for about a fortnight. The eye itself was not blood-shot, and there was no discharge from it. She always thought the right eye to be rather larger than the left. Two months ago she first noticed a white speck on the patient's right eye, which had increased in size. The child was born at full time; no instruments were used. It is her fifth child; three of the others are living; one died of bronchitis.

On examination the right eye was found to have hardly any anterior chamber; pupil inactive; tension full. A yellowish reflex was seen from behind the lens. The left eye was healthy. A new growth was suspected, and the right eye enucleated.

Pathological Examination (made by Mr. Lawford, who has kindly permitted me to make use of his notes).—The eyeball was small; there was no puckering of the sclerotic. The cornea was clear. The iris was pushed forwards into contact with its posterior surface, and looked very convex anteriorly. The iris was adherent to the anterior capsule of the lens. The lens was clear and nearly globular in shape, and in contact with the posterior surface of the iris. A persistent hyaloid artery passed through the vitreous from the optic disc to the posterior surface of the lens, where there was an opaque membrane stretching across the globe. The ciliary processes were thin and elongated, and attached to this membrane. The retina and choroid appeared healthy.

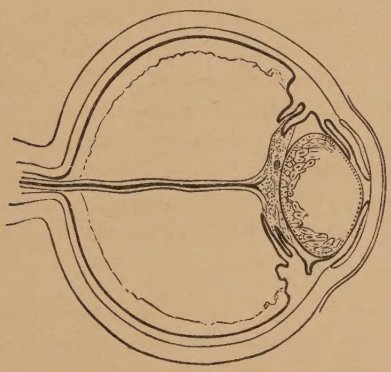


FIG. 4.—Represents a diagrammatic section of the eyeball in Case 2.

Microscopical Examination.—The iris is much bent forwards. The lens is in contact with its posterior surface. The relation of the ciliary processes to the latter is different on the two sides. On one they all pass behind it, and are very narrow and long. On the other, some pass in front and some behind, and they are shorter and broader. All those passing behind are connected by fibres with a mass of cells, some round and some fusiform, on the posterior surface of the posterior capsule of the lens, into which the persistent hyaloid artery passes and divides. Fibres are also seen passing from this mass of cells to the portion of retina between the ora serrata and the ciliary

processes, which is shorter than in the normal eye. The lens has cells lining not only its anterior but its posterior capsule also. No definite nucleated zone can be made out in the lens. There are a large number of nucleated cells like swollen epithelial cells about its posterior and lateral parts. Its posterior capsule has some wrinkles in it. The retina appears normal. The optic papilla is thicker on one side than the other. The hyaloid artery does not pass into the vitreous directly from its centre, but from the side where the thickening is. The artery has its usual coats, and is surrounded by a thick sheath, composed of cells and fibres. Red blood corpuscles can be seen in the artery. The choroid is less vascular than normal, and its cells have scarcely any pigment in them.